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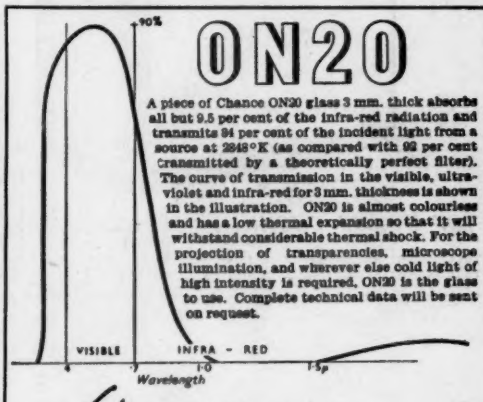

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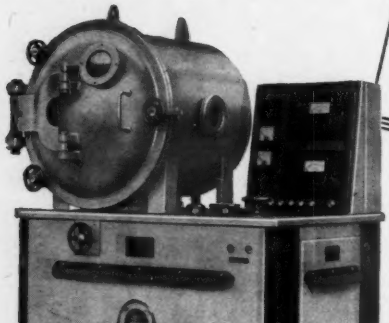

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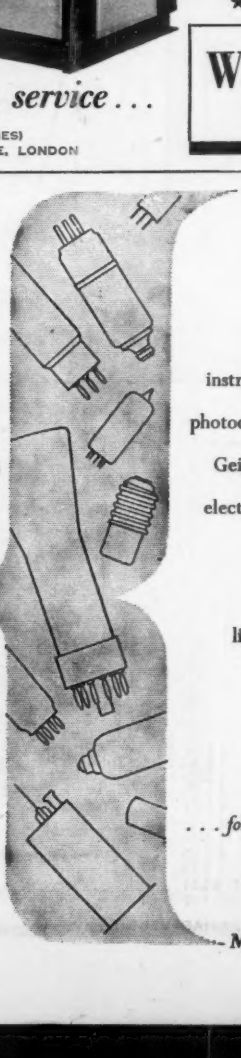

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H.M. KING GEORGE VI

THIRTY years ago, in the speech with which he declared the Shirley Institute open on March 28, 1922, the late King George VI, then Duke of York, said that to his mind the future well-being of the British people was immeasurably bound up with education and research. He was already convinced that if our conditions of living were to be improved, it was by keeping ahead of the world in knowledge through the research carried out in such institutions. Thus early the Duke revealed both his clear understanding of the purpose and possibilities of science, and the human outlook and sympathies which have consistently marked his activities before and after he came to the throne. When in a speech broadcast at the centenary celebrations of the Imperial College of Science and Technology on October 26, 1945, the King looked back over the years of the Second World War from which we had just emerged and the contributions which the Imperial College had made to victory, he emphasized that that contribution was made not only in research but also in the training of men. Another occasion to be recalled is the opening of the Royal Society Empire Scientific Conference in 1946. Speaking of the war-time developments of science, King George said: "the increase in man's knowledge of the material universe may be fraught with infinite possibilities of good and evil. This must never be used as an argument against scientific research. It should rather lead us all to seek for ways and means of increasing our respect for moral principles . . .". In opening the new buildings of the National Institute for Medical Research in 1950, he emphasized that the "work of the Institute exemplifies that spirit which inspires the State and science to work together for the health and happiness of mankind". Finally, in the speech with which King George declared the Festival of Britain open on May 3 last year, he directed attention to the vital part which scientific imagination and research play in industry. Further, he referred to the fears, so widely entertained, of the misuse of science, and he expressed the prayer and the hope that the vast range of knowledge displayed in the Festival might be turned from destructive to peaceful ends, to the greater happiness of all peoples.

All this has shown the man of science and the technologist that in King George they had one who, though not himself trained in science, understood its outlook and possibilities and shared their own most earnest desires to see the potentialities of science fully realized in the promotion of human welfare. For that alone they have special reason to share with their fellow citizens in the universal sense of loss which has so suddenly befallen the British Commonwealth of Nations.

There are, however, other associations of King George with science which may be remembered here with appreciation. Proceeding to Trinity College, Cambridge, in October 1919, after his war service in the Royal Navy and in the Royal Air Force, Prince Albert read a special course of

history, economics and civics. Shortly afterwards, his interest in industrial life led him to accept the presidency of the newly formed Industrial Welfare Society. From this office he derived much satisfaction through the close touch with men and women into which it brought him, and the many fields of industry with which he became acquainted. He remained president until his accession to the throne, when he became patron.

Although the welfare aspect of industry was perhaps that in which he was most deeply interested, the mechanical bent which had found early expression in his naval career led to a keen interest in mechanical developments in industry, and his support was likewise given to a wide range of scientific and learned societies. He was elected a Royal Fellow of the Royal Society on June 16, 1932, signing the Charter Book on November 10, and became patron of the Society after his accession. Other societies and institutions to which his patronage gave encouragement include the Royal Society of Edinburgh and many others. He was also patron of the British Empire Cancer Campaign and of the Imperial Cancer Research Fund, and took a keen interest in the campaign against cancer as well as in that against tuberculosis. His interest in horticulture and agriculture is well known, and both afforded him some scope for his scientific knowledge and interest.

King George's interests were intensive as well as extensive, and whether it was a matter of industrial welfare or some new scientific or industrial development that engaged his attention, his questions were shrewd and showed real understanding of fundamental problems. Moreover, he was capable of taking a line of his own, as when in 1921 he launched his scheme for boys' camps, and himself supervised the arrangements for the first of these. The camps, which were composed of 200 public school boys and 200 boys from working-class homes, were run under the ægis of the Boys' Welfare Association, of which the then Duke had become president in 1919. His encouragement was invaluable for the smooth running of the experiment; but the boys themselves soon made the camps into a fellowship which had its influence far and wide, and the success and value of the experiment are further attested by the numbers of schools and firms which have organized similar camps.

King George's readiness to experiment and to face change was manifest, however, in much wider spheres. Like his father, he brought to bear on his duties not only this appreciation of science and its potentialities, but also a wide knowledge of men and the conditions under which they lived. This was not limited to an understanding of industrial and social conditions in Britain itself, gained in such ways as already indicated, but was extended, again following his father's example, by visits to the Dominions and overseas territories which are part of the British Commonwealth of Nations. As Duke of York he visited Kenya at the end of 1924, and in January 1927 started on a visit to Australia lasting six months and during which he attended the inauguration of the Parliament House in Canberra. In 1939 he visited Canada, as well as the United States, and in 1947, South Africa, and had planned originally to visit Australia and New Zealand in 1949. While he had not travelled so extensively as his elder brother before he came to the throne, by training and precept he was as equipped as both his brother and his father to discharge those responsibilities which devolve on the Crown now that it is the sole link binding together the independent nations which form the British Commonwealth.

The measure of his success is attested not only by the unity of the Commonwealth during the Second World War, but still more by the messages and tributes which have been received at his death. Although the title Emperor of India was formally relinquished in June 1948, it is manifest that in India the King has been no less respected as the symbol of free association with the Commonwealth, and his death has caused real sorrow there.

The human qualities and sympathies which the King manifested so strikingly in his work for the Industrial Welfare Society and the Boys' Welfare Association played a part in thus winning the loyal support and admiration of his subjects everywhere. So, too, did his simple dignity, his sense of responsibility and devotion to duty, the determination with which he set himself to overcome his physical disability and innate shyness, and the high courage which he manifested in sharing his peoples' dangers and difficulties during the War, and in facing serenely the physical weakness of his last few months. These all enabled him to speak so effectively and intimately to his people, above all in the broadcast which many have come to regard as an essential part of Christmas itself. At the great home festival of the year, that broadcast was felt as a direct link between the King in his royal home and his peoples in theirs. Nothing has won the King and his Queen and all their family so firm a place in the affection and esteem of their people as the simplicity and happiness of their united family life. At a time when so much in our industrial and economic life tends to weaken the influence of the family and of home life in the transmission and cherishing of beliefs and habits and human values, the Royal Family has shown a whole Commonwealth of peoples not only a living proof of the power of a united family to bear trouble and confront ordeals, but also, as the Prime Minister observed in his broadcast, to transmit those principles of conduct and moral values which hold together the fabric of civilization. King George VI may well come to be longest remembered for this, beyond all his other sterling qualities; and for the part which all his family played in this, the Queen's subjects will wish the more to express to her and all the Royal Family their respectful but very real sympathy.

DIFFERENTIAL CALCULUS WITH SEVERAL VARIABLES

Vorlesungen über Differential- und Integralrechnung

Von Prof. A. Ostrowski. Band 2: Differentialrechnung auf dem Gebiete mehrerer Variablen. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Mathematische Reihe, Band 5.) Pp. 482. (Basel: Verlag Birkhäuser, 1951.) 67 Swiss francs.

THIS is the second volume of Prof. Ostrowski's lectures on differential and integral calculus, intended for independent students as well as for those taking a course at a university. The first volume, dealing with functions of one variable, appeared in 1945 and was reviewed in *Nature*, 158, 771 (1946). The present volume is described as dealing with the differential calculus in the domain of several variables, but much of it concerns only a single variable. There is to be a third volume, dealing with the more advanced parts of integral calculus.

In the preface, stress is laid on the importance of working examples, of which the book contains a very large number. Some of these are such as appear in other treatises; but more than half of them are original, including some hitherto unpublished theorems. This emphasis on examples is unusual in a Continental book; their value would be even greater if answers were given.

We shall now examine the contents in detail. The first chapter deals with sets of one dimension and of n-dimensions. A short second chapter deals with the convergence and continuity of functions of sets. Then a long third chapter (100 pages) gives the most important theorems on infinite sequences and series, and their application to the binomial, exponential, sine and cosine series. Good as this chapter is, it is certainly not concerned with functions of 'several' variables, and it might more suitably have appeared in the first volume. The same remark applies also to part of the fourth chapter, on supplements to the differential calculus. This opens with quite elementary theorems on indeterminate forms with infinite numerators and denominators, maxima and minima of functions of a single variable when the second derivative vanishes, and even Leibniz's theorem on the nth derivative of a product. It then proceeds to functions of several variables, taking the fundamental theorem to be that of the mean value. It is unfortunate that it is necessary to rely on a formula concerning functions of two variables that was included in the first volume. However, after this, all is clear, and we get an account of partial derivatives, Taylor's theorem for functions of several variables, Euler's theorem on homogeneous functions, the total differential, uniform differentiability, and conditions for the inversion of order of partial differentiation.

The fifth chapter, on applications of the differential calculus to analysis, is one of the best in the book, and deals principally with Jacobians and their application to functional dependence. The theorems are enunciated and proved with unusual care. This chapter also includes an account of implicit functions and of maxima and minima of functions of several variables. The sixth chapter deals with numerical methods, including those of Lagrange, Gregory–Newton, Simpson, Gauss, and Newton–Raphson. Again we remark that the functions concerned are those of a single variable.

The two remaining chapters deal with differential geometry. The seventh chapter starts with the parametric representation of curves in two and three dimensions, and their tangents and normals. Some of this work is surprisingly elementary; for example, it is explained at length how to find the equation of the tangent at a point of an ellipse, and how to deal with the particular case of the circle. After a brief discussion of singular points it proceeds to rectification and to curvature, evolutes and envelopes of plane curves.

The eighth chapter starts with vectors and their scalar and vector products. It then discusses the osculating plane of a space-curve, and its curvature and torsion, using the moving trihedral and obtaining Frenet's formulæ. The rest of the chapter deals with the properties of surfaces, including tangent planes and normals, and the envelopes of families of surfaces depending on one or two parameters.

The general impression made by the book is very good. The style is clear, and the printing, paper and binding are of very high quality. Unfortunately, the price also is very high. There is no index, but an index to the complete work will appear at the end of the third volume. The reader is warned in the preface that in the second volume 'Sin' and 'Cos' are used for the hyperbolic functions denoted in the first volume by 'sinh' and 'cosh'.

H. T. H. PIAGGIO

VIRUSES AND MAN

The Essentials of Virus Diseases

By Dr. Patrick N. Meenan. Pp. vii+260. (London: J. and A. Churchill, Ltd., 1951.) 20*s*. net.

MANY people, even teachers of bacteriology, feel that viruses are the subject of an esoteric science, incapable of study or comprehension by ordinary mortals. As a result, students are often not well instructed about them. Viruses have always been important as causes of disease in man: now that bacterial infections are being better and better controlled by antibiotics, the relative importance of virus diseases becomes steadily greater. Dr. Patrick Meenan, of Dublin, has written a little book in which the "essentials of virus diseases" are presented for the benefit of the practising physician and the medical student; and, be it noted, virus diseases for him are the virus diseases of mankind. He has done a remarkably good job. There are three introductory chapters on characteristics of viruses, methods of study and control; then he gets down to dealing seriatim and in orderly sequence with the essentials of the chief viruses affecting man, in fifteen chapters; there is a final chapter on the collection of specimens for laboratory diagnosis. Viruses which are omitted from his presentation are those of molluscum contagiosum, infectious warts and, surprisingly enough, the common cold.

Though the presentation is in text-book manner, Dr. Meenan has a pleasant, readable style, and his judgment is well balanced. The printers and publishers must have put his material through quickly, for the book is remarkably well up to date, an important point in such a rapidly growing subject. If anything, Dr. Meenan is a little too eager to

include 'the very latest'. I would advise him to consider the evidence very critically before he states in his next edition that varicella can be cultivated in the testes of rabbits.

Such a book necessarily invites comparison with others published recently on similar lines, and it has, when so assessed, certain clear points for and against. It is rather less full than the other books I have seen, and does not, as some of them do, include the rickettsiæ—apart from some mention of *Q* fever. It is particularly brief as regards theoretical aspects and only contains such reference to laboratory methods as the general reader will require to know. There are seven figures (maps or diagrams) but no photomicrographs or electron micrographs. As the preface states, "bibliographies have been omitted in an attempt to keep the book within reasonable limits". It would seem a pity not to have given references at least to those larger works in which the inquirer could seek how to gratify his curiosity; viruses form such a challenge to the curious that it would be disappointing if no reader were stimulated to further reading or research.

On the other hand, the book does what it sets out to do. Its very conciseness will appeal to many students and medical men who have not the time for prolonged study, and it is a few shillings cheaper than its rivals. It is no mean feat for a single author to have written a book which covers so well what are the "essentials of virus diseases" for the doctor and medical student.

C. H. Andrewes

THE WISDOM OF A THOMIST

Philosophy of Nature

By Jacques Maritain. To which is added Maritain's Philosophy of the Sciences, by Yves R. Simon. Pp. x+198. (New York: Philosophical Library, Inc., 1951.) 3 dollars.

IT is hard to realize, in the mill-race of modern life, that something has been going on for some years, very quietly and unobtrusively, but which, apparently, has made few eddies and whirlpools in Great Britain. This is the revival of Thomism, particularly in France: the book under review is by a master hand, and in addition the reader is given a conspectus of his philosophy, accompanied by a shrewd estimate of the intellectual potential behind it.

Before attempting an analysis of this work, it is well to state that the greater part is a translation, unfortunately not too successful. Nothing misleading is introduced, but awkward and non-idiomatic nouns and adjectives abound, which combine to make the subject, essentially somewhat difficult to grasp, and exceedingly delicate in poise, even more strange to contemporary eyes and minds. The reader who is prepared to walk like Agag, however, will see through most of this, and perceive beneath it the majestic clarity traditionally found in French expositions.

The body of the volume consists of three well-balanced parts: first, a discussion of the ancient philosophers' conceptions and difficulties; second, the positivistic outlook, and the modern reactions against it; and third, the Thomist position. Much of the first two sections is common knowledge, and unlikely to engender any appreciable disagreement. By far the most important feature is the diagrammatic treatment of Aristotle's three degrees of abstraction, corresponding to physics, mathematics and metaphysics. These are delineated as spheres, upon which the 'glance' of the investigator is taken to be incident. Exactly what type of knowing results depends upon whether penetration, refraction, or even critical reflexion takes place at the boundaries or within each universe of discourse. Later, the idea of stratification is introduced, in place of homogeneity within any particular region. Lastly, information acquired within one sphere can be carried forward and projected into another. For example, the domain of mathematics may be illuminated directly or via the medium of sensible matter (in our language, experimental physics). The interest of this would seem to lie in providing an æsthetically acceptable picture of the well-known reciprocity between the pure and applied sciences, in stimulating research and discovery. On a higher level maybe, pure mathematics has occasionally been advanced by the needs of the physicist, or at least by his aspirations. This effect receives recognition by implication in such a scholastic framework, formal as it is. Nevertheless, it is unlikely that anybody grappling with Nature in the raw will derive much comfort from exercises of this kind; the point is that, as heirs of a complex tradition, we are enriched by the vision back down the ages of thought and its object.

In connexion with the influence of the Renaissance, Maritain comes, perhaps unintentionally, near to exaggerating the importance of certain great intellects, like Leonardo da Vinci. It is, of course, freely acknowledged by everyone how the great artist-engineer became ever more and more engrossed in the veneration of natural law, and how studiously and relentlessly he sought out and pondered the works of Archimedes. Yet his inability to generalize, on one hand, and the impracticability of his 'machines', on the other, combine to deprive him of any very effective part in carrying the torch of learning in this specific instance. His own genius, so high above almost any crowd of heads, appears scarcely of the type best fitted to transmit a philosophy akin to the perennial.

One may note in passing the able account given by the author of the reactions against the positivistic school of science. The views of such scholars as Duhem, Myerson and Husserl are well known. Max Scheler is less read in Great Britain: he has exerted considerable influence upon the biologists—or at least upon some of them—and this has naturally affected Maritain himself, who was at one time a pupil of Driesch. What the phenomenologists are concerned to achieve is a far deeper disposition of the percipient than merely to 'explain'; they wish to 'understand', and to this end they strive to establish an intuitive science. Although embedded in a vast network of ratiocination, this means, quite simply, 'why' rather than 'how'.

Nevertheless, to return to the main theme, it would seem unlikely that any species of the *philosophia perennis* will escape the need to convince twentieth-century thought that it contains within itself at least the essential ingredients of a progressive member of the knowledges (to recapture a plural used by the late Dr. F. R. Tennant). Metaphysics may well recover to new life and fresh conquests, but her problems will not be solved *permanently* (and that is the operative word) by reliance upon *a priori* constructs. If this review interprets Maritain correctly, he is broadly in sympathy with this opinion, as indeed many of his past labours tend to confirm.

One has now, therefore, to see what lies before him, if this great task of bringing up from the recesses of the mind of St. Thomas Aquinas the very core and substance of the Angelic Doctor's thinking is not only to be accomplished, but also to be accepted in one's own generation.

To appraise the chances of such an enterprise, one dominant feature must be kept in focus from the start. Thomism resembles a jewel set in a matrix of very earthy material. Maritain is perhaps the only authority alive capable of performing the desperate and laborious operation of extraction. Chemists would rightly describe it as analogous to Mme. Curie's historic effort in producing a fractional quantity of radium from a ton of pitchblende. It may well be that what is recovered from the thirteenth century will prove correspondingly penetrating. But Maritain's vista inclines to pessimism in foreshadowing a continuous state of restlessness between the camps of philosopher and man of science. One must realize that nobody could possibly have composed a more completely Thomist book than his earlier work "Degrees of Knowledge". On this account, he is entitled to his own—rather melancholy—estimate of how far into the ore he must dig. In a letter, he once wrote that "[some people] believe they have just to crack the shell to get the nut". But he might have added—had he thought of it—that the anchoress Lady Julian of Norwich (who died between 1478 and 1483) saw, in the course of her first revelation, a vision of a hazel-nut "as round as a ball"; and she thought what it might be. "And it was answered generally thus—*It is all that is made.*"

F. I. G. RAWLINS

THE SOCIAL SCIENCES

Analysis of Society

By Leo Silberman. Pp. x+262. (London, Edinburgh and Glasgow: William Hodge and Co., Ltd., 1951.) 15*s*. net.

MR. L. SILBERMAN has set out in this book to provide a general account of the objectives and methods of the social sciences, with special reference to work being carried out in Great Britain. Its theme is the development of a statement, made in the first chapter, to the effect that: "If the empiricists showed that sociology is impossible without first-hand contact with ordinary people, then they have also shown that these first-hand contacts are by themselves insufficient. Without hypotheses they are odd bits of interesting information not analysis". This is a promising beginning, in so far as it is high time that attention should be directed to the dangers inherent in the development of 'pure' theory alongside equally respectable and almost equally insignificant 'pure' field researches.

In general, however, the book contains an account of the concepts developed by the various schools of sociological thought and an outline of the ways in which these concepts have been applied to everyday problems of social organization. The ground covered in this way by Mr. Silberman and Mr. Stuart Chase's "The Proper Study of Mankind" is similar in extent; the value of the two books is also of the same order, but while Mr. Chase concentrates with some precision on 'practical' issues, Mr. Silberman pays more attention to the more 'academic' type of theorizing. Mr. Silberman is most at home in discussing the implications of the work of Freud and Marx for social analysis in general, and it is a pity that he has not attempted to show how far the lines of thought that have been developed from them can be reconciled, or if that can be done at all. His method of examining each school of thought on an independent 'level' makes it difficult to obtain a clear idea from his discussion as to the directions in which development is now taking place, and the final effect is to accentuate rather than clarify the muddle which social scientists have created for themselves in recent years.

ECONOMIC ASPECTS OF ELECTRICAL ENGINEERING

Electrical Engineering Economics

A Study of the Economic Use and Supply of Electricity. By D. J. Bolton. Vol. 1: General Principles and Choice of Plant. Pp. xi+292. (London: Chapman and Hall, Ltd., 1950.) 25*s*. net.

MR. D. J. BOLTON'S writings on the economic aspects of electrical engineering already have an established place in the literature of the subject, and the appearance of a third edition of "Electrical Engineering Economics" will be welcomed. This work, in the new edition, occupies two volumes, and the present review refers to the first of these. This first volume is, in turn, divided into two parts—Part 1, "General Principles"; and Part 2, "Choice of Plant".

The earlier chapters, which deal with basic considerations, give a simple and clearly written treatment of what may be termed the conventional economic principles. The standard formulæ relating to interest, depreciation and sinking funds are derived in a straightforward manner, and the principles of application of the formulæ illustrated by numerous examples. Part 1 is completed by a chapter on productivity.

In Part 2 the principles are applied to a range of problems concerned with the selection and design on economic grounds of electrical engineering plant. After an introductory section giving a general classification of electrical losses and their costs, separate chapters deal with the economic choice of cables, transformers, motors and lamps. While the subject is developed with specific relation to each of these varied branches, emphasis is maintained on the common underlying principles. The author's approach to his subject is indeed well expressed by a quotation from the chapter on transformers and motors. "When Lord Kelvin enunciated the law for cables that bears his name he did far more than merely express a rule for choosing conductor sections. He foreshadowed an entirely new principle of design and selection, applicable in some degree to every kind of electrical plant. He and Dr. John Hopkinson were in fact the joint founders of electrical engineering economics."

Three appendixes complete the volume, the first comprising a useful set of economic tables, the second constituting a detailed study of the payment for capital assets in the case of a large organization such as an electricity undertaking, and the third dealing with the under-running of electrical plant. Matters relating to electricity supply appear only incidentally

in this book, as that topic constitutes the subject of the second volume. The author, in the preface, refers to the fact that it has not been possible to recast the many numerical problems on the basis of post-war costs. This is surely an omission for which little apology is needed in these days.

When the first edition of this book was produced more than twenty years ago, the recognition of the importance to all engineers of an elementary knowledge of basic economics applied to their special fields was by no means universal as it is to-day. For the electrical engineer Mr. Bolton's book rendered fundamental economic considerations readily intelligible through the medium of familiar problems. Despite the price changes which have made so many of the examples no longer representative and the much more far-reaching changes which have taken place in the general economic structure, Mr. Bolton's book remains an excellent introductory treatise useful both to the student and to the practising engineer.

James Greig

DESIGN AND FITTING OF LABORATORIES

Laboratory Design

National Research Council Report on Design, Construction and Equipment of Laboratories. Edited by H. S. Coleman. Pp. ix+393. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1951.) 96*s*. net.

FROM time to time the scientific professions bestir themselves, sit back from their microscopes and balances, and cast a jaundiced eye around their work-places, the offices and laboratories, lecture theatres and test-shops in which they pass their lives. So many of these places are inadequate in so many ways that dissatisfaction wells up and erupts in meetings and symposia of the kind organized a year or so ago by the Institute of Physics at the Royal Institution. This gathering of distinguished people discussed at considerable length the problems which remain conspicuously unsolved in the design of physics laboratories. More recently a meeting of the Royal Institute of Chemistry considered the shortcomings of chemistry laboratories, and revealed a great many. Neither discussion has had any significant influence on designers because very few designers were invited to hear the scientific workers' views, and none was asked to present his own. Here is an odd state of things. It is as though one might complain of an ill-fitting suit, but not allow the tailor to get near enough to take one's measurements.

American men of science, if not yet actually anxious to be measured, at least recognize the need; and Mr. H. S. Coleman, who, as chairman of the National Research Council's Committee on Design, Construction and Equipment of Laboratories, has edited this imposing volume of essays, has been careful not to exclude contributions from architects, though they amount to only four in a total of forty-two. One of the four is, however, the introduction, by Mr. Roland Wank, a member of the architectural firm of Fellheimer and Wagner, of New York, and he makes good use of so prominent an opportunity to emphasize the vital importance of the architect's role in any building project. He points out that ". . . the architect pre-occupied with appearance and devoted to strait-jacketing functional requirements into a Gothic or Renaissance shell has become rare to the point of extinction . . ." and claims with every justification that the architect-authors of other papers in the book reveal their "grasp of the whole range of problems from site selection to the last shut-off valve". It is therefore disappointing to find, on turning to the section devoted to descriptions of modern laboratories, that, with two marked exceptions, the architectural character smacks unpleasantly of the Great West Road out of London, and in at least one case the spacing of the windows in the more recent additions is stated to be controlled by the 1929 "classic" proportions of the original building. (The "classic cornice and detail" are, however, omitted.)

If this means that examples of good contemporary laboratory design are as hard to find in the United States as they are in Great Britain, the lack of a comprehensive reference work of this sort may well have been at least part of the cause. It will no longer be an excuse, for in one way or another—and frequently more than once—every aspect of the subject is here touched upon. The material is arranged in four parts. Part 1 has, as well as the introduction, six essays by specialists in the various fields of services, plumbing, furniture, safety precautions and, most important, materials suitable for use in the interior construction of laboratories. Parts 2 and 3 deal respectively with the requirements of teaching and industrial laboratories, and Part 4 consists of "concise" descriptions of finished laboratories. It is mainly in this part that references to research laboratories are to be found. The editor's declared policy has been to allow each contributor to express his views freely, and there has been no attempt to "conciliate conflicting opinion or eliminate . . . repetition". The result is that the book is almost too lavish. There is so much reading matter in it (little of it 'concise' as the word is understood in paper-starved Britain) that one is almost handicapped when seeking specific information by the temptation to 'browse' in interesting and enthusiastically presented matters which may not be one's immediate concern.

This is not to deny the book's immense value, of which there can be no doubt whatever. But if another edition is contemplated, would it be too much to ask that one section at least should present the basic information in some sort of classified or tabulated form for quick reference? This would help both the scientific worker and the architect—the one in the formulation of his 'brief', the quality of which has a much more important influence on the success of the finished building than is generally appreciated, and the other in his complex task of seeing the job whole without losing sight of the detail.

The book is handsomely produced on art paper. The text is set in 10-point Rockwell (attractive to look at but a little tiresome to read) with headings and sub-headings in heavy Gill sans, type faces which compose well with the frequently occurring photographs and line drawings. The illustrations are not as good as they should be in such a volume; they illustrate well enough, but they scarcely ever grace the pages, and in some cases—p. 165, for example—they are disastrously large and black and ugly. Neat little free-hand sketches at one-third the size would have been quite adequate for most of the essays. A book on design should set the best possible example.

S. Meyrick

The Preparation of Programs for an Electronic Digital Computer

With Special Reference to the EDSAC and the use of a Library of Subroutines. By Maurice V. Wilkes, David J. Wheeler and Stanley Gill. Pp. xiii+170. (Cambridge, Mass.: Addison-Wesley Press, Inc., 1951.) 5 dollars.

THIS is the first published account of all the details necessary for the preparation of a mathematical problem for solution by the University of Cambridge computer EDSAC.

It is in three parts, bound in one volume. The first part begins with a chapter introducing the basic features of an electronic digital computer in so far as they concern the user, giving the 'order code' and the method of decimal to binary conversion and deconversion. Subsequent chapters describe the input of orders, the use of previously prepared and checked programmes for subsidiary calculations encountered in the course of the problem (known as 'subroutines'), the means adopted to eliminate errors of all kinds, and the use of the EDSAC organization as a whole. The first part ends with several examples worked in detail, including the evaluation of a definite integral, the integration of an ordinary differential equation, and Graeffe's root-squaring process for the solution of algebraic equations.

Part 2 gives the user's specifications of nearly all the subroutines already compiled in the EDSAC 'library', and Part 3 describes the actual sequences of orders in certain selected subroutines.

The subject-matter is concisely yet very clearly presented, with notably few misprints, in a slim and stoutly bound volume. M. WOODGER

Photometric Atlas of the Near Infra-Red Solar Spectrum λ8465 to λ25,242

By Orren C. Mohler, A. Keith Pierce, Robert R. McMath and Leo Goldberg. Pp. iv+7+234 plates. (Ann Arbor: University of Michigan Press, 1950.) 4 dollars.

THIS is the first of a series of projected publications dealing with solar radiation in the near infra-red region. A companion volume will list the wave-lengths, equivalent widths and identifications of the features given here as intensity tracings, and future atlases will show laboratory spectra of such telluric molecules as H_2O, CO_2, CH_4 and N_2O in this region. For the present work, the McMath–Hulbert infra-red spectrometer, which employs a plane grating and lead-sulphide photoconductive cell, was used on the Snow telescope at Mt. Wilson. The linear response of the cell enables a direct pen recording of infra-red intensities to be made: the tracings in this atlas are photo-offset reproductions of these recordings, reduced to five-eighths of the original scale. The shortest wave-length overlaps by 300 A. the longer limit of the Utrecht (photographic) atlas, and by 5000 A. the long-wave limit of the photographic work (not, however, yet reproduced as tracings) at Mt. Wilson.

The resolving power, which averages about 30,000, is insufficient to reveal the true profiles of the narrower lines, but equivalent widths may be derived with fair accuracy by correcting for non-linearity and for scattered light. The light used was that of the centre of the sun observed near meridian passage in clear dry weather. Perhaps the least satisfactory feature of the atlas is the wave-length scale, (determined mainly by the method of overlapping orders), which is indicated by labelling minima only every 40 A. or so along the traces; but even so, linear interpolation gives wave-lengths of intermediate features correct to about ± 0·1 A. The atlas is a major work invaluable to astrophysicists, spectroscopists and meteorologists alike.

Fundamentals of Physical Chemistry

For Premedical Students. By Prof. H. D. Crockford and Prof. Samuel B. Knight. Pp. xi+366. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 34*s*. net.

THE authors of this book are both professors of chemistry at the University of North Carolina. They have written for pre-medical and biological students on those sections of physical chemistry necessary for an understanding of medicine and biology. The emphasis is therefore on such items as solution, electrolytes, the conception of *p*H, osmotic pressure, chemical equilibrium, buffer action, adsorption, the colloidal state and radioactivity. The only noticeable omission is the partition coefficient, a knowledge of which is helpful in the study of the action of anæsthetics. Knowing, as it were, the background of medical students, the authors have dispensed with the calculus; but the treatment with simple mathematics is quite thorough and is supported by numerous clearly worked out examples. In addition, there are ample sets of questions and numerical problems. The various concepts are expounded with unusual clearness, the subject-matter is up to date and the illustrative examples are appropriate and attractive. I believe that many will welcome and approve of the innovation (Chapter 7) of considering the direction of flow of the electrons as the direction of the flow of the current. Despite the title, this is a good and reliable introduction to physical chemistry for any type of student. G. FOWLES

Corrosion Guide

By Erich Rabald. Pp. vii+629. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) 90*s*.

THIS book has forty-five pages on general principles, followed by more than five hundred pages of tables summarizing experience of various materials in numerous environments. What value the book has lies in the tables: the general sections will tell the corrosion specialist nothing he does not know already and a good deal he has (rightly) forgotten, while by their diffuseness they will tend to confuse the non-specialist.

In the tables, four categories of corrosion resistance of materials to environments are distinguished, based where possible on practical experience, and otherwise on laboratory determinations of weight-loss per unit area per unit time. Few indications of liability to pitting, intergranular corrosion or stress corrosion are given—a serious limitation in a book addressed to chemical engineers.

Perhaps the best test of a guide is that of use. While considering this review, I had occasion to seek data on the resistance of zinc to oxalic acid solutions, and that of several metals to nitrite solutions, but found the book silent on these matters. In better-known fields, such as the behaviour of metals with ammonium sulphate solutions and with sea water, the book provides some accurate, but also some misleading, information (very little about sea water). No information is to be found on galvanized iron,

and only moderately accurate notes concerning tinned ware. The 'stainless' ferrous alloys, aluminium, and copper and its alloys are, however, treated adequately. Even here, the lack of specific references (which the general bibliography, although excellent for further reading on corrosion, does not ameliorate) makes the following up of the condensed information impossible.

Another irritating feature of the book is the inadequate translation, especially of much of the established corrosion terminology. No one would defend corrosion jargon except as convenient usage; but terms found in the book such as "gap corrosion", "economical pickling additions", "refinement of potentials", "oxidizing covering layer", "pittings", are no improvement. The great number of misspellings, misprints and mis-hyphenations may also distract the reader.

Despite these numerous faults, corrosion specialists and chemical engineers should consult the book for hints on new problems, for admittedly such consultation might sometimes save many months of work.

T. P. Hoar

British Bird Books

An Index to British Ornithology, A.D. 1481 to A.D. 1948. By Raymond Irwin. Pp. xix+398. (London: Grafton and Co., 1951.) 63*s*. net.

THIS book is a model of painstaking industry. The author, Mr. Raymond Irwin, says it is "intended as a practical tool for the working ornithologist", to whom it will certainly be most helpful.

The volume is divided into five parts: subject lists, the subjects ranging from bibliography, through ecology, territory and photography, to falconry, etc; regional lists; a systematic list; index of authors; and an index of subjects, species and places. There are also two appendixes, the first consisting of the addresses of national societies, unions, periodicals, etc., while in the second is to be found a supplementary list for 1949–50, with index.

The short introduction affords interesting reading with its review of present-day ornithology. As Mr. Irwin very truly says, "The interest in field ornithology which in recent years has spread to so many thousands of amateurs has coincided with a change of emphasis in the science of ornithology itself. Interest has shifted, or rather developed, from the study of the dead bird to the study of the living organism". This aspect of modern ornithology is illustrated in the index by the many pages devoted to listing books bearing on it. But from whatever angle an ornithologist views birds, this book will aid him in his work.

Frances Pitt

Totem Poles

(Canada: Department of Resources and Development, Development Services Branch.) National Museum of Canada, Bulletin No. 119. Anthropological Series No. 30. By Marius Barbeau. Pp. xii+434. (Ottawa: King's Printer, 1950.) 2.50 dollars.

THIS is a very useful and interesting book by one of the chief authorities on the subject. It consists of an introduction, followed by sections dealing with individual types of pole, classified according to the principal objects represented on them. The introduction is the most valuable part for the general reader. It sets forth, clearly and concisely, the facts about the growth of the art of wood carving, which is much more recent than is generally believed; in fact, both the scale of the carvings and many of the motifs are due to contact with the white man, his tools and his ideas, while the style remains strictly indigenous.

The remaining sections, forming the bulk of the book, comprise descriptions of individual poles and of the legends and folklore which have grown around particular crests. This part is a mine of interesting information, but the arrangement leaves something to be desired. There is no index, and it is sometimes difficult to find where an illustration is referred to in the text; in fact, I failed to find any reference whatever to some of them. This is described as Vol. 1; it is not clear what subjects future volumes will deal with, but it is to be hoped that they will include a comprehensive index.

The preface claims that the volume includes some notice of all known totem poles, house posts and frontals, but it is inevitable that some should have escaped the author's notice, particularly among those now outside Canada. Two examples in the Museum of Archæology and Ethnology, University of Cambridge, have been omitted: one is a fine Haida pole 48 ft. high, with a good many features in common with No. 42 in the book, and the other is a Kwakiutl Grizzly Bear house post; both were collected by W. A. Newcombe in 1926. Some confusion has arisen over the two poles in the British Museum (Nos. 8 and 9 in the list), both of which are described in the book as Eagle-Halibut poles, whereas only one actually falls into this category. This is due to the fact that one of the illustrations does not represent a specimen in the Museum.

G. H. S. Bushnell

Good Land from Poor Soil

By Edward Ringwood Hewitt. Pp. 137. (Trenton, N.J.: Trenton Printing Co., Inc., 1951.) 1.50 dollars.

THIS book is written primarily for farmers in the eastern part of the United States. The author in the course of a long life has managed to divide his energies between industrial chemistry, engineering and agriculture. His particular interest has been the reclaiming of worn-out or derelict grassland farms, building up their fertility and improving their output. His thesis is that 'land robbery' as a policy has now reached its natural end in the United States, since there is practically no new land to take up. The new task is to get the run-down land back into profitable cultivation, and this depends on a knowledge of the principles of soil fertility and the necessary capital to put them into effect.

Mr. E. R. Hewitt, while giving full credit to the advisory services and official bulletins and publications, takes the view that the fundamentals of soil fertility need restating in a compact form. Sections deal with soil acidity, organic matter and the major and minor nutrients. The background is provided by the author's own analyses of soils from his fields and the treatments with limestone and fertilizers that he has based on the results. British farmers would not find the book easy to read because they seldom think in terms of pounds of 'available' nutrients per acre, relying more on considered recommendations based on the soil examinations made by their specialist advisers. Apart from soil analysis, Mr. Hewitt's general conclusions in regard to the improvement of the yield and quality of hay and pasture are in general along lines familiar in Great Britain.

TOTAL SOLAR ECLIPSE OF FEBRUARY 25

By Prof. F. J. M. STRATTON, O.B.E., F.R.S.

A TOTAL eclipse of the sun, with a duration of totality of about three minutes at the most favourably placed stations, will take place on February 25 next. The eclipse commences at dawn in mid-Atlantic, and the belt of totality reaches land in French Equatorial Africa near Libreville. It then passes across Africa to the Sudan, where El Obeid and Khartoum are near the central line and Port Sudan is on the southern edge of the belt; crossing the Red Sea and Arabia, where Jeddah is just south of the belt, it passes through Kuwait, Iraq, Iran and Central Asia and ends in Siberia. Basra in Iraq is again just south of the belt.

Originally, three expeditions, spread out from the Sudan to Iran, were contemplated by the Joint Permanent Eclipse Committee, but financial reasons, difficulties of transport and political conditions led to considerable alterations of plans, and in the end only two expeditions are being sent, one from Cambridge and one from the Royal Greenwich Observatory. Generous offers of assistance were received from the Foreign Office, the Services, the Ministry of Supply, the Sudan Government, the Suez Canal Company, and various oil companies (Kuwait, Iraq and Anglo-Iranian). Unfortunately, for the reasons indicated, not all of these could be accepted in the end.

The Admiralty has taken full responsibility for the Greenwich expedition, which consists of four parties, two in the Sudan, one in Kuwait and one in Iraq. The parties are under the direction of Dr. R. d'E. Atkinson, chief assistant of the Royal Observatory. The programme includes the measuring of a long-line geodetic arc between the Sudan and Iraq and a study of the moon's limb profile. The method of observation is by accurately timed cinematographic photographs of the revolving solar crescent as seen at four stations just outside the belt of totality. Two pairs of stations will be established, one near each end of the arc; each pair will place its stations on opposite sides of the belt.

The Cambridge University expedition, under Prof. R. O. Redman, is being financed by the Government Grant Fund of the Royal Society. It is to be stationed close to Khartoum. Prof. Redman will be studying line profiles in the chromospheric spectrum in continuation of work at the eclipses of 1940 and 1936. He will be using the Cambridge Observatory Rowland concave grating in the second order, with a dispersion of about 2·2 A./mm. Dr. H. von Kluber will be carrying out photographic photometry of the corona in polarized light with special attention to the inner corona. Determination will be made of electron density near the sun's limb, and variations in latitude and over sunspot areas will be looked for. Dr. D. E. Blackwell will be scanning the corona with a lead sulphide cell to get information on differences of intensity distribution within the corona between the infra-red and the region near λ 4000 A.; a study of the mechanism of scattering involved in the corona should follow from the observations. Prof. H. Zanstra (Amsterdam) is joining the party and using the Hills quartz spectrograph to examine the discontinuity in the continuous spectrum of the chromosphere at the head of the hydrogen Balmer series. He has shown that this should give a value of the electron temperature of the chromosphere. Dr. Houtgast and Mr. de Jager from Utrecht will also join Prof. Redman's party.

The third party from Great Britain originally contemplated was a radio party from the Army Operational Research Group and the Telecommunications Research Establishment. This had to be cancelled in the end, but luckily its programme is largely covered by that of a party from the Naval Research Laboratory, Washington, D.C. In addition to high-speed low-resolution spectra of the sun's limb and high-resolution flash spectra near the limits of the Balmer and the Paschen series, this party is measuring the intensity of radio-frequency radiations at 10 cm. and 8 mm. wave-lengths. Another expedition from the United States is being organized by the National Geographic Society, and part of its programme is an attack on the Einstein deflexion of light, to be carried out by Prof. G. A. van Biesbroeck. Both these parties will be stationed near Khartoum. Prof. J. Hargreaves, of the University of Ottawa, is also bringing an eclipse party and may be at Khartoum or at a high-level station near the Red Sea.

Naturally, the Royal Observatory, Helwan, Egypt, is sending an expedition under Dr. M. R. Madwar. Its programme is a photographic photometric study of the corona and a spectrographic study of coronal lines in the blue-violet and ultra-violet. This party will be in close touch with a French party under Dr. B. Lyot. An Italian party from the Astrophysical Observatory at Arcetri will consist of Prof. G. Abetti and Drs. A. Colacevick, G. Righini and Fracastoro. Their programme includes a flash spectrum in the ultra-violet with a concave-grating spectrograph and one in the visible region with a plane-grating spectrograph; also coronal photographs, with a long-focus lens for the inner corona and a short-focus lens for the coronal extensions, and a camera working at $f/0{\cdot}8$ and spectrograph for the infra-red spectrum of the corona.

A large party under Prof. M. Waldmeier, of Zurich, consisting of Dr. Leutenegger, Prof. Schürer, Mr. Scherrer and Prof. E. Guyot and several others, including two mechanics, is taking out fifteen instruments. Their programme includes the following: structure of the inner corona, photometry and polarization of the corona in the photovisual region with an absolute comparison with the brightness of the solar surface; structure of the outer corona in red light; contour of calcium lines in the outer corona; comparison of the absolute intensities of the continuous spectrum of the corona and of a few emission lines; electron density in prominences and limb darkening on the disk. Most of these parties will be clustered around Khartoum, and it must be hoped that the favourable weather conditions confidently anticipated there at this time of year will be present for the eclipse.

One further expedition is projected—from the Kodaikanal Observatory, India, under Dr. A. K. Das. This party expects to go to Iran or Iraq, more probably the latter country. Nothing has yet been reported of the plans of the Soviet astronomers in Central Asia.

Mention must also be made of elaborate preparations made for the eclipse by the Joint Commission on the Ionosphere of the International Council of Scientific Unions. In close co-operation with

the International Union of Radio Sciences, observations of radio noise are to be made at a network of stations, mostly outside the belt of totality but on both sides of it. A study of the behaviour of the E, F_1 and F_2 layers during the eclipse will be made. The Department of Scientific and Industrial Research is sending Mr. W. R. Piggott to Ibadan, Nigeria, and Mr. C. M. Minnis to Khartoum.

The eclipse will be visible as a partial eclipse in the British Isles about 0900 h. on February 25. The magnitude of the partial eclipse will be about 0·11.

ORIGIN OF THE EARTH

GEOPHYSICS has hitherto relied mainly on the principles of mechanics of solids and fluids, assisted by geology and atomic physics, especially in relation to the outer parts of the earth. Prof. Harold C. Urey has now produced[1] a new synthesis largely based on physical chemistry. Long as the paper is, it is very condensed and could have been made into about ten papers. The central principles are as follows:

(*a*) Kuiper's theory of the origin of the solar system is adopted. This requires the planets to have been derived from much more massive protoplanets, which lost the greater part of their mass in the process.

(*b*) The planets grew by accretion of solid planetesimals, up to some hundreds of kilometres in diameter. The surface features of the moon are regarded as produced by impact of such planetesimals in orbital motion about the earth.

(*c*) A discussion of the stability of various chemical compounds under different temperatures and pressures reveals some difficulties about the retention of certain elements, notably nitrogen and carbon. This indicates a high temperature at some stage, but not general fusion.

(*d*) The planets in consequence are supposed to have started as cold bodies, but to have become hot mainly on account of heat developed in accretion.

(*e*) The earth's central core is identified with iron and the inner core with nickel, and it is held that there is still considerable admixture of iron in the rocky shell to within a few hundred kilometres of the surface.

Whether the conclusions are accepted or not, the arguments are novel and important, especially the chemical ones. In what follows I shall mention some outstanding difficulties.

I am not satisfied by any existing theory of the origin of the solar system. Kuiper's appears to fail on account of the Nölke difficulty, that mass lost by the planets would not have enough angular momentum to leave the system. It must either remain spread through the system, where it would probably be visible and would certainly produce secular perturbations of the planets' orbits that are not observed; or it would be absorbed into the sun and make its rotation too rapid. While, again, accretion may be important, it is not clear that the large planetesimals are possible in sufficient numbers. My original argument against the planetesimal hypothesis was that the planetesimals, if they contributed a large fraction of the planets' masses, must have had a much larger total surface than the planets. Consequently, they would collide with and volatilize one another before the planets could grow appreciably. The argument was answered by A. L. Parson, who showed that the density of the resulting gas would be greater than the saturation density, so that the gas would at once re-condense into dust. But it is difficult to understand why growth occurs by picking up large planetesimals.

Urey, like Hoyle, regards the lunar maria and craters as produced in the early stages, in this respect differing from Baldwin, the chief protagonist of the meteoric theory. I myself still think a volcanic theory tenable. On an accretion theory Urey, again like Hoyle, shows that the earth would become fluid if the material took less than 10^8 years to collect, but would remain solid if it took longer. Urey prefers the latter alternative, Hoyle the former. For myself, I do not see how the strong concentration of radioactive elements near the surface could have occurred except as a result of general fusion and recrystallization; and I know of no satisfactory alternative to the subsequent thermal contraction as an explanation of mountain formation.

W. H. Ramsey's hypothesis that the earth's core is a high-pressure modification of olivine is rejected by Urey on the ground that if it was correct the mean density of the earth, reduced to zero pressure, would be about 3·3, whereas Urey gets about 4·4. But the latter result is got by extrapolating Bullen's pressure-density relation for the core down to zero pressure. It is no argument against Ramsey, because if he is right there is an intervening discontinuity in the relation, and the extrapolation is illegitimate.

Bernal's explanation of the 20° discontinuity in seismology as due to a transition from rhombic to cubic olivine is also rejected, because Urey's coworkers have not succeeded in preparing the cubic form of Mg_2GeO_4 reported by Goldschmidt, from which Bernal inferred the possibility of cubic Mg_2SiO_4 at high pressure. This is an awkward fact; but it is hard to see how Goldschmidt could have been mistaken. Urey proposes instead that the discontinuity is due to admixture of metallic iron. This, however, would not explain the facts. The fundamental fact is that the times of seismic waves at distances from about 15° to 25° indicate a rapid increase of velocity with depth, starting at a depth that might be 150–500 km. on various interpretations. The increase of density inferred by Bullen is a secondary result. The elastic moduli of iron are not very different from those of olivine, and admixture of iron would reduce the velocities of elastic waves on account of the high density. Consequently if Urey's interpretation was right, the velocities would decrease with depth instead of increasing.

The variation of velocity of seismic waves with depth is smooth from a depth of 800 km. or so until a little outside the core; but just outside the core the variation becomes much less rapid. Bullen pointed out that this could be explained by admixture of denser material. Urey's notion of admixture of iron would agree here. Urey suggests further that settling of iron into the core is still going on (he considers that on the whole the planets acquired their silicates first and that iron planetesimals were added later). This would decrease the moment of inertia and produce a secular acceleration of the rotation. This would tend to explain the fact that the observed secular accelerations of the sun and moon are not in the ratio predicted by the theory of tidal friction.

The densities of the inner planets had appeared to be consistent with either the iron-core theory or with

Ramsey's. In either case the densities would require the relative size of the core to increase with the mass of the body, and a theory to account for this on the iron-core hypothesis had been proposed by Lyttleton. Ramsey and Bullen found that the data are approximately reconciled on Ramsey's theory, attributing a uniform composition to all the bodies with discontinuities of density at certain pressures. Mercury, however, has contributed little to the comparison on account of the uncertainty of its mass. But E. Rabe's recent work, based on the perturbations of Eros, combined with the old diameter, makes the density nearly as great as the earth's. Rabe's determination looks thoroughly reliable, and Urey thinks that the old diameter is more likely to be too large than too small. If this is so, Mercury affords strong evidence against similarity of composition, and it would have to be mainly iron.

Other evidence is given from Mars. Harrison Brown finds the ellipticity almost in agreement with uniformity of density. On this ground, Urey regards Mars as a mixture of iron with silicates, like certain meteorites; there has been little separation of materials, as in the earth. However, the argument from the ellipticity appears to be based on a hydrostatic theory, and in a discussion of the same problem I found that the departure of the ellipticity from the hydrostatic value, with a considerable central condensation, is not too great to be explained by a strength in the neighbourhood of that of much of the earth's shell. Accordingly, I do not find the evidence for the homogeneity of Mars convincing.

The theory, therefore, appears to need considerable modifications; but it is certainly stimulating.

HAROLD JEFFREYS

[1] Urey, H. C., "The Origin and Development of the Earth and other Terrestrial Planets", *Geochimica et Cosmochimica Acta*, **1**, 209 (1951).

LIPOID CHANGES IN THE GONADS OF WILD BIRDS

THEIR POSSIBLE BEARING ON HORMONE PRODUCTION, SEXUAL DISPLAY AND THE BREEDING SEASON

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Comparison between Male and Female Cycles

IN the males of several widely unrelated birds there is, at the conclusion of spermatogenesis, exhaustion and breakdown of the interstitial cholesterol-containing lipoid Leydig cells and a massive metamorphosis, involving the production of lipoids and cholesterol, of the remaining contents of the seminiferous tubules[1,2]. When a testis metamorphoses and collapses after the breeding season it does so completely, and it is therefore impossible to agree that the differential sexual cycles of migratory and 'stationary' starlings (*Sturnus vulgaris*) are the result of the testes of "one type . . . not regressing so far as the other"[3]. The new generation of Leydig cells remains minute and meagrely lipoidal for a time and is presumably unable to produce sex hormone, while the tubules, clotted with fatty debris, cannot produce spermatozoa: the refractory period begins and the organ will not respond to artificial photostimulation. Meanwhile, a new testis tunic arises, the new Leydig cells manufacture cytoplasmic lipoids which are cholesterol-positive, and the tubule lipoids and their cholesterol begin slowly to disappear. The tubule-clearance rate varies from species to species.

It appears inconceivable that the reservoir of slowly disappearing cholesterol is functionless. We believe that it may be a source of androgens during the post-nuptial summer period while the new interstitium remains comparatively immature. Androgens cannot be stored in the animal body, and so during the period of interstitial inactivity the production of sex hormone should have value in preserving aggressive behaviour in food gathering, the retention of the former place in the peck-order (in colonial species) and so on. Towards the end of the above-described period of reorganization and rehabilitation—the old term 'regression' no longer covers the known facts—the interstitium can once more respond to neurohormonal influences initiated by changes in the environment. As the next breeding season progresses and the tubules ripen, the Leydig cells gradually give up their lipoids and cholesterol, and so spermatogenesis and interstitial exhaustion occur once more.

An investigation of the ovarian changes of a non-migratory wild bird (the rook, *Corvus frugilegus*, L.) has not revealed a corresponding post-nuptial period when the ovary lacks what appears to be the essential apparatus of ovulation, that is, non-atretic follicles and large numbers of cholesterol-positive lipoidal 'interstitial' cells scattered through the stroma. The cycle appears to be as follows. Ovulation occurred in March (in Cornwall) and the successive empty follicles were quickly invaded by blood cells and fibroblasts which built up bands of connective tissue across them. These sometimes converted a single discharged follicle into several scars, making it impossible to determine the age by a scar count as in mammals. At the time of ovulation both interstitial and thecal cells were largely depleted of their cytoplasmic lipoids and cholesterol. While the female was incubating or attending the young, follicles continued to develop and to undergo lipoidal atresia. As the atretic follicles became sudanophil they produced cholesterol and in them appeared numbers of lipoid cells that enlarged and became distributed as interstitial cells through the neighbouring stroma as each old follicle lost its identity. Small patches of hyaline tissue incorporating old and distorted nuclei remained for a time as the only trace of the larger atresias.

Early in May, when the young were about to leave the nest and the male testis tubules were packed with post-nuptial lipoids (Fig. 1), follicle growth to a diameter of about 800 μ continued and each follicle involuted and produced its quota of interstitial cells (Fig. 2). Moulting began in June, and from then until towards its termination (late in September and early in October) the ovary continued active but to a lesser degree. At this autumn period, at a time of resurgent male display and occasional spermatogenesis, the majority of females showed increased activity involving the loss of interstitial lipoids and oocyte growth to a diameter of 1 mm. externally

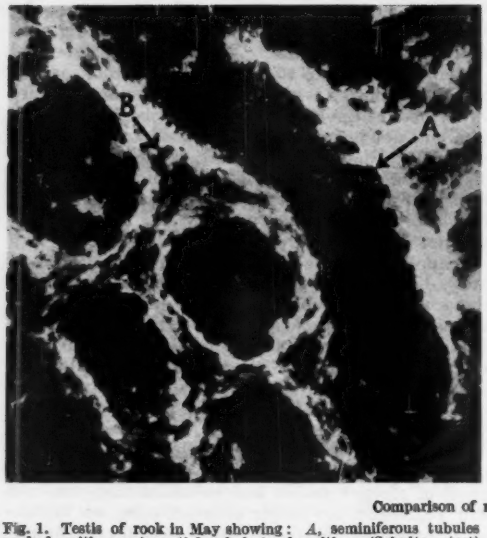

Fig. 1. Testis of rook in May showing: *A*, seminiferous tubules packed with post-nuptial cholesterol-positive (Schultz test) lipoids; *B*, inconspicuous regenerating interstitium. (Approximately × 350)

Fig. 2. Ovary in May (arrow indicates 'interstitial-cells' from nearby atretic follicle (× 100)

Comparison of male and female cycles

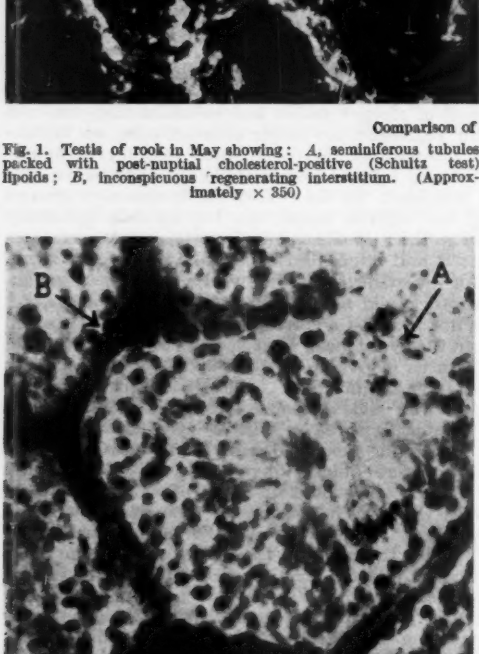

Fig. 3. Testis in February showing: *A*, cleared tubules and first spermatozoa of new season; *B*, mature, cholesterol-positive interstitium (× 350)

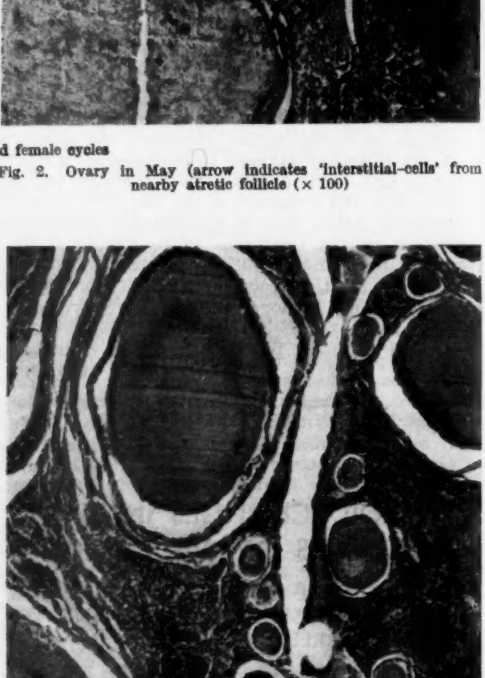

Fig. 4. Ovary in February of generally similar appearance to that of May (× 100). (Baker's formal-calcium fixation and Scharlach R. colouring at 10 μ)

visible to the naked eye. Many pairs now began refurbishing their nests and one bird, hatched the preceding April, ovulated. From late November to January there was a lessening of ovarian activity, and at the same time sexual behaviour was substantially depressed during the colder, duller, leafless and possibly hungry period. There is evidence that the males that achieved autumnal spermatogenesis now underwent a second tubule metamorphosis but the ovaries remained meagrely productive, developing oocytes 500 μ in diameter before atresia.

Although there had been minor seminiferous activity even before the winter solstice, the 'spring' gametogenetic advancement began late in January and early in February. This led to the appearance of spermatozoa in mid-February (Fig. 3) at a period when the largest oocyte was still only 3 mm. in diameter. But even though the follicles remained relatively small (Fig. 4), repeated atresias greatly increased the number of interstitial cells, and numbers of lipoid cells began to enlarge in the theca interna of each larger one that survived. Thenceforward follicle activity was intensified, resulting in the maturation of thecal cells, great numbers of atresias and more and more interstitial cells. As sexual display, nest-building and copulation activity increased, thecal and interstitial cells lost their lipoids and the cycle culminated in a sudden and rapid increase in follicle size which resulted in ovulation during the first half of March.

It is not suggested that the above-described ovarian cycle is typical, except in broad outline, of seasonal birds in general. For example, the ovaries of south-bound passerine migrants in September and October are full of small (35 μ in diameter) atretic follicles which, heavy with lipoids and cholesterol, show no sign of conversion to interstitial cells. We do not know whether these, in some species, cause an ovarian refractoriness such as occurs in the testis.

Possible Site of Oestrogen Formation

It was considered for many years that the follicle granulosa cells are the site of production of the ovarian œstrogens; but there has arisen a body of evidence that does not support this view in the case of mammals[4]. The above-described distribution of cholesterol may have bearing on this point in the bird. Cholesterol is unmistakably present in all sudanophil material within the ovary but completely absent from peritoneal fat deposits immediately outside it. Cholesterol occurs in the maturing thecal cells of the ripening follicles and in atretic follicles from the appearance of the first faint tinge of lipoid and right through the interstitial cycle to the final exhaustion of the individual cells. In fact, the only prominent ovarian cells that do not contain cholesterol at some stage of their cycle are the granulosa cells. In the male the cholesterol is removed from the interstitial cells as the sexual season heightens until, at the peak of spermatogenesis, little or none remains. Likewise, in the active ovary there is a steady depletion of cholesterol from both thecal and interstitial cells although, as stated before, repeated atresias ensure that the cholesterol reservoir is maintained. Similar events have been observed in many species as widely unrelated as a petrel, gull and passerines other than the rook. There is ground, then, for a belief that, in the bird, female sex hormone emanates primarily from the large cholesterol reservoir that is maintained throughout life by the lipoid cells, although it cannot be denied that the granulosa cells may play some part in the transmission of the final product to the follicles.

Of recent years there has been much discussion as to which cells—thecal or interstitial—produce the ovarian androgens. The females of several species of birds, including the rook, exhibit 'masculine' activity in varying degree as an apparently normal, unpathological aspect of autumn behaviour. We have examined one such female and found a seemingly normal proportion of both thecal and interstitial cells in the ovary. However, the proportion of small follicles that were lipoidally atretic and unconverted to interstitial cells was relatively higher. Further, the 'masculine' individual had outer adrenal cortical cells (which in the bird are interdigitated with those of the medulla) considerably depleted of lipoids along with a corresponding diminution of cholesterol.

Timing of the Breeding Season

It has been suggested[3] that the northern nuptial journey of migratory birds from climatically equable equatorial regions may be controlled primarily by the internal rhythm of the testis, and we believe that such a mechanism should be considered as a possible regulator of the 'spring' sexual activity of many tropical, pelagic and other non-migratory species as well. The existence of an internal testis rhythm is physically indicated by the changing distribution of the lipoids as described. At the end of the summer–autumn moult the interstitium has matured sufficiently apparently to secrete a little and to stimulate the characteristic autumn display of various species. In the rook this occasionally leads to gametogenesis; but the bulk of the males retain much of their tubule lipoids until the following January or early in February, when the 'spring' spermatogenesis begins. The generally held concepts are that birds begin their spring sexual resurgence under the influence of a certain specific day-length or light increment. Several species, however, regularly begin spermatogenesis in January when light changes are exceedingly minute and the days, in a foggy climate, are less than one hour longer than at the winter solstice. Again, during the mild early winter of 1951 some Buckinghamshire robins began their 'spring' spermatogenesis before the winter solstice. Before we can discount the possible influence of an internal rhythm in, for example, the rook, we must explain: (*a*) if a certain minimum day-length alone causes sexual resurgence, why do 10–15 per cent of males within the same area reach a potentially reproductive condition at about October 1 when the days are more than 2·5 hours longer than those at about February 1, by which time the general population begins to do so; and (*b*) if a change-over from decreasing to increasing day-length is held to be responsible, why do many females exhibit minor gonad activity and a small percentage of both sexes achieve gametogenesis in October?

In some species it seems more likely that, after a more or less stable period of tubule refraction, it is a combination of environmental factors such as sunshine (as opposed to mere day-length), warmth and food abundance which makes for neurohormonal stimulation; this gives rise to increased song and sexual display, such activity leading to a mutual heightening of the sexual processes of all mature individuals in the area. (In this respect it is not inappropriate to mention a caged canary that whistles vociferously in winter whenever a vacuum cleaner is used and which responded vigorously to a shepherd's whistle during the radio broadcast of autumn sheep-dog trials.) We believe, then, in the possibility of a fixed period of tubule refractoriness continuing in most individuals past the autumn days of clement weather and abundant food and waning in time for the population in general to react to external stimuli in winter and spring. Such a negative period could arise by natural selection because the autumn matings of rooks and most other species rarely produce young that survive. At present we know little about the relationship between the anterior pituitary and the gradual clearance of cholesterol from the tubules and vice versa. It seems established[4] that injected androgens check gonadotrophin output in mammals and thus, too, indirectly depress testis activity in birds[5]. It will be recalled that it is only after the tubules are almost cleared that the interstitium begins its seasonal leap in species so far studied in detail. It could still be held, of course, that minute day-length fluctuations of winter stimulate both final tubule clearance and interstitial advancement, but that will not explain why some robins begin their 'spring' development some days before the winter solstice while others in the same wood do so a little after it.

Once the winter pre-nuptial development gets under way the males far outstrip the females in gametogenesis in all nine Australian and British species so far studied. The testes quickly produce

spermatozoa; but the oocytes remain relatively minute, seemingly until the seasonal advent of environmental factors that permit successful reproduction. For example, the males of a breeding rookery feed the incubating females and later the nestlings as well. It is certain, then, that the food supply within each restricted area must have become sufficiently abundant to be gathered by one bird of each pair before reproduction can take place. It is significant that rooks—and other species—do not breed at precisely the same time each year. Records[5] kept by the Marsham family in Norfolk for about two hundred years indicate that the first rooks appear at any time between March 23 and May 2, with a mean during mid-April. It seems clear that whatever *initiates* the sexual cycle, the ovulation date is governed and the breeding season ultimately timed, not by unvarying photoperiodicity but by local stimuli that vary in time of onset from year to year and which probably operate through the exteroceptors of the female. Any theory of avian breeding seasons based primarily on internal rhythm and secondarily on various environmental changes has the advantage of possible application to all seasonal species whether they breed in the spring, in the depth of winter (as does the Antarctic emperor penguin) or on the equator, where light fluctuations are too small to command consideration.

We wish to thank Mr. Charles Boswell for help in the field.

[1] Marshall, A. J., *Q. J. Micro. Sci.*, **90**, 3, 265 (1949).
[2] Marshall, A. J., *Wilson Bull.*, **63**, 4, 238 (1951).
[3] Bullough, W. S., *Phil. Trans. Roy. Soc.*, B, **231**, 165 (1942).
[4] Burrows, H., "Biological Action of Sex Hormones" (2nd ed., Cambridge).
[5] Chu, J. P., *J. Endocr.*, **2**, 21 (1940).
[6] Margery, I. D., *Q. J. Roy. Met. Soc.*, **52**, 27 (1926).

SCIENTIFIC RESEARCH AND THE ART GALLERY

NUFFIELD FOUNDATION RESEARCH SCHOLARSHIPS AT THE NATIONAL GALLERY

AN article published in *Nature* of October 8, 1949, p. 601, described the activities of the Scientific Department at the National Gallery, London, and emphasized the dual character of its functions. Thus, there is the day-to-day work in conjunction with the restorers, and, in parallel, the need for long-term investigations into relevant problems at present little understood, or at best only imperfectly formulated. The pattern is a familiar one, long recognized in industry and in medical science. If the outstanding questions regarding the care of paintings of national —indeed of international—importance are ever to be tackled in a fundamental sense, then some system of research scholarships tenable at an institution which is itself a collection of supreme pictures has for some years seemed the only way of grappling with these problems upon a truly scientific basis. In this context, it is perhaps too readily assumed that industrial processes and data of roughly analogous kinds can be taken over bodily and applied to the cases in point; experience has shown that this is by no means so. Many substances of interest in the arts have no real counterpart in industry, and furthermore, for a great public gallery, very long views need to be taken of all technical developments. What may be done to a masterpiece is not done for a year or two, but for decades, and perhaps for centuries; and again, the unique character of the material itself, and its irreplaceability, need no stressing.

It was a deliberate assessment of all these factors which led the Nuffield Foundation to offer to provide two graduate scholars, and an assistant, to work in the National Gallery laboratory under Mr. F. I. G. Rawlins for a period of three years. This is believed to be the first instance, anywhere in the world, in which a grant has been made to enable the sciences to come to the help of the humanities in a field such as this, demanding the prosecution of studies far removed from an *ad hoc* character, but yet orientated specifically towards the task of conservation. The research team has recently been completed, and now consists of Mr. J. S. Mills, of the Imperial College of Science and Technology, London (chemistry), Mr. I. Graham, of Trinity College, Dublin (physics) and Miss J. Wilson (technical assistant). Although the scholars are at liberty to pay brief visits to other laboratories in order to become familiar with specific techniques, their work is essentially concentrated at the National Gallery itself.

The main theme is the chemistry and physics of diffusion and swelling—together with solvent action —in films. In short, this is but one aspect of the vast subject of colloid science, and is clearly fundamental for any exact understanding of the properties and behaviour of surface coatings, linoxyn films, whether pigmented or not, and the mechanical aspects of such films when swollen. An interpretation in terms of surface energy and thermodynamic potentials would be a natural extension, more especially in view of the somewhat confused state of knowledge relating to moisture permeability and the influence of relative humidity, both when equilibrium may be assumed to be established and when stratified systems such as classical paintings are involved in cyclic changes and consequent hysteresis. The whole outlook might perhaps be envisaged as one of 'micro-cleaning', and thus it is essential to bring about the interlocking of the chemical and physical approaches by reference to the general concepts of the colloidal state.

Separating the whole programme into the appropriate chemical and physical sectors, it is proposed to use the principles of chromatography extensively in the former, and an optical (interference) system for the latter. Progress can already be reported in the separation of a number of components from the natural resins, using solid absorbents and paper chromatographic techniques. This stage is a necessary prelude to further examination. Meanwhile, a modified form of the method of observation initiated at the Research Laboratory, Courtaulds, Ltd., Maidenhead, is proposed to deal with the diffusion problem. In this, the advancing boundary of attack is followed by means of the fringes produced in a suitable optical path. In the past, some weight has been given to the idea of a 'solvent differential', as a discriminant for the use, or non-use, of any given solvent in respect of its action upon a surface film (varnish), and its essentially inocuous effect upon the paint-layer below, considered as an aggregate of pigment particles in dried linseed oil (linoxyn), and including the case of vanishingly small pigment concentration. It seems more than likely that in many instances the phenomenon of preferential diffusion is much more significant: in fact, two superposed chemically similar phases can be imagined in which the passage of the penetrant

could be so controlled as to act upon the upper stratum alone, ignoring the lower, a condition of affairs in which the solvent differential would obviously be zero. Academically, a complete examination of the anisotropic character of diffusion is of much interest, as recent theoretical investigations have revealed.

From the methodological angle, it is necessary to recollect that a long series of tests upon (necessarily) over-simplified examples will be needed before it is possible to go over to the extremely complicated, and largely empirical, circumstances of application in the restorers' studio. In this lies the intrinsic value of the present opportunity. *En route*, some recourse will probably be had to various micro-dissection techniques, and apparatus is available with that in mind. If and when a tolerably complete grasp of the whole matter in its basic form has been achieved, the incidental, but practially important, question of the optimum conditions for the easy and rapid removal of over-paint from pictures will almost certainly be answered automatically.

In all these ways, it is intended to attempt fundamental advances in our knowledge both of the materials and phenomena which are of direct significance in the care of a great collection of paintings. Without the generous support of the Nuffield Foundation, it is difficult to believe that such an enterprise could ever have been contemplated. Moreover, the National Gallery is now in the unique position of being the locus of research which should not only benefit the priceless patrimony in the care of the Trustees, but also, through publication of the results in due course, render a service to the responsible tasks of curatorship throughout the world.

NEWS and VIEWS

Institution of Electrical Engineers: Honorary Members

THE Council of the Institution of Electrical Engineers has elected the following to honorary membership of the Institution: Sir Arthur Fleming, for his distinguished work in electrical engineering, in particular in the field of technical education, his contributions to scientific research, and his services to the Institution; and Sir Edward Appleton, for his distinguished work in the field of pure and applied physics and his researches into the characteristics of the ionosphere and the part they play in determining the mode of propagation of radio waves.

Faraday Medal

THE Council of the Institution has made the thirtieth award of the Faraday Medal to Prof. E. O. Lawrence, for his distinguished work in the field of nuclear physics. Prof. Lawrence, who was born in Canton, South Dakota, on August 8, 1901, was educated at the South Dakota, Minnesota, Chicago and Yale Universities and became professor of physics at the University of California in 1928. Lawrence's early researches were concerned with photoelectric effects, and in 1930 he became interested in the possibilities of using the method of resonance acceleration in order to obtain positive ions of very high energies by means of a number of consecutive accelerations through relatively low differences of potential. His recognition, however, of the limitations of this method of linear resonance acceleration led him to conceive and build the first cyclotron, which he used to study the transmutation of elements and artificial radioactivity. For this work he was awarded the Nobel Prize for Physics in 1939. During the Second World War Prof. Lawrence was a member of the team of American and British scientific men concerned with the development of fissile materials. The need for larger samples of uranium-235 than could be obtained by the mass-spectrograph method led him to investigate the large-scale separation of uranium isotopes by electromagnetic methods. He achieved success by employing the 'Calutron' mass separator, and this method of effecting the large-scale separation of uranium isotopes was adopted in preference to the two other methods (the centrifuge and diffusion systems) which were under investigation at the same time. Among Prof. Lawrence's honours are the Hughes Medal of the Royal Society and the Duddell Medal of the Physical Society.

Veterinary Science in the Ministry of Agriculture: Sir Thomas Dalling

SIR THOMAS DALLING, chief veterinary officer of the Animal Health Division, Ministry of Agriculture, is to retire at the end of March. Born in Edinburgh in 1892, a son of the forge, and educated at George Heriot's School, he entered the Royal (Dick) Veterinary College in 1910 and qualified M.R.C.V.S. with honours in 1914. As a student in Edinburgh he was outstanding in his year, and also gained the FitzWygram and Williams Prizes open to all students qualifying in the veterinary colleges of Great Britain and Ireland. After a short period in general practice he joined the Army Veterinary Corps and served in France during the First World War, where he was employed in various veterinary laboratories. On demobilization in 1919 he returned to general practice for a very short time; but opportunity to join Prof. Gaiger at the Glasgow Veterinary College as research worker in bacteriology led to his becoming chief investigator of the Animal Diseases Research Association, founded and maintained by subscriptions from the farming community and interested agricultural bodies in Scotland. In 1923 he became veterinary superintendent of the Wellcome Physiological Research Laboratories at Beckenham, where he carried out research on disease problems, including blackleg in cattle, leptospirosis in dogs, canine distemper and bovine tuberculosis. During 1937–42 he held the chair of animal pathology at the University of Cambridge.

Government service opened a wide field for Sir Thomas's organizing and research ability when he became director of the Veterinary Research Laboratory of the Ministry of Agriculture at Weybridge in 1942; and on the retirement in 1948 of Sir Daniel Cabot, chief veterinary officer of the Ministry of Agriculture, he succeeded him. For many years he has been a member of council of the ruling body of his profession, the Royal College of Veterinary Surgeons, and on the reconstitution of the Council following the passing of the Veterinary Surgeons Act of 1948 he was appointed president of that body, and was re-elected the following year. Since the end of the War, his advice on the control of animal disease has been sought by practically every country in

Western Europe, where his reputation as a veterinary scientist and administrator stands high; and it is to be hoped that use will continue to be made of his outstanding gifts in the international field of veterinary science.

Mr. J. N. Ritchie

Mr. J. N. Ritchie, deputy chief veterinary officer, is to succeed Sir Thomas Dalling. Born in Turiff, Aberdeenshire, in 1904, Mr. Ritchie received his early education at Turiff Secondary School. He then studied at the Royal (Dick) Veterinary College and the University of Edinburgh, obtaining the diplomas of M.R.C.V.S. in 1925 and D.V.S.M. in 1926, and graduating B.Sc. in veterinary science in the University of Edinburgh in 1927. After six months as a clinical assistant in the Royal (Dick) Veterinary College, he entered the veterinary service of the City of Edinburgh as assistant veterinary inspector. During 1929–35 he was veterinary officer to Midlothian County Council, and during 1935–38 he held a special appointment as senior veterinary officer in the Department of Agriculture for Scotland to administer a scheme of attestation to combat tuberculosis in dairy herds in Scotland. The success of this scheme in Scotland was largely due to the pioneer work stimulated by Mr. Ritchie, and served as a guide when a similar scheme was launched in England and Wales. At the time of the incorporation of the local authority veterinary services within the Animal Health Division of the Ministry of Agriculture in 1937, Mr. Ritchie joined the State service and was posted to Perth as superintending inspector, where he remained until 1940. After three years at the head office of the Animal Health Division, he was sent to the United States to study all aspects of veterinary research and the control of animal diseases in that country. When, in 1946, it was decided that there should be a greater degree of devolution of Government administration of Scottish affairs from London, Mr. Ritchie was transferred to Edinburgh as deputy chief veterinary officer for Scotland and veterinary adviser to the Secretary of State for Scotland, and has continued in this appointment up to the present time. Apart from Mr. Ritchie's wide administrative experience and knowledge of disease control, he has played an important part in the development of the comparative test for tuberculosis, by means of which in the past few years considerable advance has been made towards freeing the herds of Great Britain from this major scourge.

Mr. D. S. Barbour

Mr. D. S. Barbour, chief superintending veterinary officer, Animal Health Division, Ministry of Agriculture, has been appointed deputy chief veterinary officer and will succeed Mr. J. N. Ritchie in Edinburgh as adviser to the Secretary of State for Scotland. He was born in Colmonell, Ayrshire, in 1899 and received his professional training at the Glasgow Veterinary College, from which he qualified M.R.C.V.S. in 1924. After three years in general veterinary practice in Essex he was appointed in 1927 assistant veterinary officer to the County of Ayr. On moving from Ayrshire in 1934 he became veterinary officer for the County of Devon, and on the incorporation of Local Authority Veterinary Services within the Animal Health Division of the Ministry of Agriculture in 1937 he received the rank of divisional veterinary officer; he was promoted superintending inspector in 1944 while serving at the head office, and in 1948 became chief superintending veterinary officer.

Mathematics at University College, Aberystwyth: Prof. G. J. Kynch

Dr. G. J. Kynch, whose appointment as professor of applied mathematics at the University College, Aberystwyth, has been announced recently, is a graduate of the Imperial College of Science and Technology, London, where he obtained first-class honours in mathematics in 1936 and the Ph.D. in 1939. He remained at the Imperial College until 1941, and during that time was mainly interested in the theory of molecular structures, a field in which he collaborated closely with Dr. W. G. Penney. After a short time as a schoolmaster, he joined the staff of the University of Birmingham in 1942. Until the end of the War he was connected with the atomic energy project, and made contributions to the theory of blast waves, the equation of state for air at extremely high temperatures, and the theory of diffusion of gas mixtures through capillaries. Since then his chief interest has been the theory of nuclear forces, but discussions with members of the applied science departments at Birmingham have also led to some work on the theory of sedimentation and other problems of a more practical nature. As secretary of the committee of the non-professorial staff, as vice-president of the Birmingham branch of the Association of University Teachers, and in other capacities, he has taken a very active part in the life of the University of Birmingham, and his imminent departure will leave a noticeable gap.

Philips' Diamond Jubilee

Sixty years ago, in May 1891, the Philips' Lamp Works were established at Eindhoven by Dr. G. L. F. Philips, a graduate engineer of Delft. For the golden jubilee, in 1941, no special celebrations were planned because of the enemy occupation of the Netherlands; but, on the anniversary, the factory workers and afterwards almost the entire population of Eindhoven, quite unexpectedly and spontaneously, ceased work, set out in procession and entered into boisterous merrymaking which was brought abruptly to an end only by the threat of armed intervention by the occupation authorities. Fortunately, the diamond jubilee occurred in more favourable times, and to celebrate the event the editors of the *Philips Technical Review* issued a special jubilee edition (13, No. 1–2; July–August, 1951). The history of the Philips concern is to be written separately and will appear shortly in book form. The contents of the jubilee edition of the *Review* are therefore confined to an illustrated description and appreciation, by Dr. W. de Groot, of some aspects of the scientific research work carried out, mainly in the physical research laboratory, at the Philips' works during the past sixty years. A most interesting, and remarkably wide, range of important research projects are being pursued in the physical laboratories, and Dr. Groot's account of these, and of the older researches, is well worth study by most physicists and electrical engineers.

G. L. F. Philips himself was the first research worker, and until 1913, when he decided to engage a physicist, the firm employed mostly mechanical and electrical engineers and chemists engaged on the production of filaments for incandescent lamps. With the advent of the gas-filled lamp the need for physicists arose, and on January 2, 1914, Dr. (later Prof.) G. Holst joined the firm. Under his direction, and with the able assistance of Dr. E. Oosterhuis, a

physical laboratory was established and a period of rapid development and expansion followed, in which many new and important products appeared. This development is described by Dr. Groot by considering three separate periods: 1914–23, the period of the First World War and during which the laboratory was located in the lamp factory; 1923–40, beginning with the opening of a specially equipped new physical laboratory and ending with the enemy occupation; and 1940 to the present day. In 1946 Prof. Holst retired from active management, and since then, although he has remained a continuous adviser, the work of the physical laboratory has been directed jointly by Prof. H. B. G. Casimir (physics), Dr. H. Rinia (electrical engineering), and Dr. E. J. W. Verwey (chemistry).

Interchange between the Universities of the British Commonwealth

At the first Congress of the Universities of the British Commonwealth held at Oxford in the summer of 1948, it was agreed that official bodies should be invited to provide funds to enable members of teaching staffs on leave to travel within the Commonwealth, and to facilitate visits of distinguished scholars of one part of the Commonwealth to another. As a result, funds were provided by the British Council, and a joint sub-committee was formed at the end of 1948 to draw up regulations for the award of the new travel grants, and to recommend awards. This body, known as the Committee for Commonwealth University Interchange, was re-appointed at the end of 1950, with an enlarged membership, and now consists of representatives nominated by the following organizations: the Committee of Vice-Chancellors and Principals; the Association of Universities of the British Commonwealth; and the Universities Advisory Committee of the British Council. The chairman is Mr. C. R. Morris. A report on this Committee for the two years up to March 31, 1951, has now been published (pp. 16; London: British Council, 1951), and this records the origins of the scheme and the visits of those who have participated in it. For the journeys undertaken in the year 1949–50, the first year of the working of the scheme, the British Council provided a sum of £5,000; last year this was increased to £7,000. In view of the steady increase in the demand, a sum of £9,000 has been set aside for 1951–52, and it is envisaged that a gradual expansion to an annual expenditure of £15,000 will eventually be attained. It is to be hoped that in due course it will be possible for Commonwealth Governments to make parallel contributions to the scheme. The conditions of award originally drawn up by the Committee have remained largely unaltered, provision being made for three categories of award: *A*, university teachers or officers on recognized study leave; *B*, distinguished scholars and scientific workers invited by universities for short visits; and *C*, postgraduate research workers holding research grants. Those given awards under categories *A* and *C* receive a fixed sum equal to the average cost of a return passage in the tourist class. Under category *B* the actual cost of each journey is paid for.

Primary and Secondary Standards at the National Physical Laboratory

The first of a new short series of pamphlets on "Units and Standards of Measurement employed at the National Physical Laboratory" has recently been issued (pp. 12; London: H.M.S.O., 1951; 9*d*. net) and deals with the fundamental units of length, mass and time, together with the derived units of volume, density and specific gravity, gravity, force and pressure. Definitions of these units are given in both the International Metric and British Imperial systems, the systems normally used by the National Physical Laboratory. The absolute value of the acceleration due to gravity, determined and used at the Laboratory, is included, and barometric pressure is dealt with in a separate section of the pamphlet. The pamphlet, though admirably concise, contains much general, as well as technical, information. The locations and form of the various material length and mass standards, such as the Imperial Standard Yard and the Imperial Standard Pound in the custody of the Board of Trade, are described, and mention is made that recent developments in the production of monochromatic light from a pure isotope of even mass-number, for example mercury-198, may soon make possible the adoption of a wave-length standard as the ultimate reference for all measurement of length. It is interesting to note that, in connexion with the wave-length standard of the cadmium red radiation in normal air, the angstrom can for all practical purposes be accepted as equal to 10^{-10} metre. In the section on time, some idea as to the extremely high order of accuracy attained in the measurement of standards can be obtained. It is stated that, owing to the nature of the radio signals broadcast through Rugby from Greenwich, by which errors in the precision clocks are determined, the precision of their comparison with the clocks is limited to a few tenths of a millisecond, but the intercomparison of the clocks themselves can be carried out considerably more accurately.

The Mpongwe People of Gabon Colony

A study in French entitled "Étude Historique sur les Mpongoues et Tribus avoisinantes" (Mémoires de l'Institut d'Études Centrafricaines: No. 3. Pp. 69 and a map; Brazzaville, 1950; 300 francs) has been written by R. P. Gautier which relates to the people inhabiting the estuary of the Gabon River, who refer to themselves as Mpongwe. The author, for fifty years resident in the Colony of Gabon, is an authority on the Mpongwe language, which he has classified as north-west Bantu. In this monograph he sketches the history of the Mpongwe and of the Gabon Colony down to the period of permanent French occupation. The first four sections are an ethnological examination of Mpongwe oral traditions which suggest that the Mpongwe came from the hinterland in the neighbourhood of the Upper Ivindo, a tributary of the Ogowe River, and that they were the first people to reach the estuary. The author examines this point in some detail, since it contradicts the view put forward by M. Avelot in 1905 that there were other tribes derived from the Congo already living there when the Mpongwe arrived. The last two sections of the monograph are historical and deal first with the Mpongwe's early relations with the French and then with the establishment in 1850 of Libreville, a settlement which, as its name suggests, was intended to be a French counterpart to Freetown and Liberia.

Scientific Method in Industrial Medicine

The Medical Research Council has published, under the title "The Application of Scientific Method to Industrial and Service Medicine" (pp. 112; London:

H.M.S.O., 1951; 3s. net), the proceedings of a conference on this subject held during March 1950. It is impossible in a short space to indicate the full value of this publication, which will interest workers in more than one scientific field. To the section dealing with scientific method in field surveys, Prof. A. Bradford Hill contributes a paper on the general principles of field surveys, while other papers discuss sickness incidence, medical field surveys in industry and the Armed Services in relation to laboratory research, occupational factors in peptic ulcer, and occupational and domiciliary factors in pulmonary tuberculosis. Two sections of the report deal with the investigation of health hazards and include papers on fluorosis and beryllium, the experimental assessment of the toxicity of chemical compounds, methods of studying the connexion between dust and disease, the psychological assessment of shortness of breath and coalworkers' pneumoconiosis (also discussed in Mem. No. 25 of the Medical Research Council, entitled "The Social Consequences of Pneumoconiosis among Coalminers in South Wales" (pp. 54; London: H.M.S.O., 1951; 1s. 9d. net)). Two further sections in the report deal with the improvement of human performance by laboratory studies and include a valuable paper by Sir Frederic Bartlett on the laboratory analysis of human activities, and papers on the effects of warmth on comfort and efficiency, on the effects of heat and on anatomical factors in machine design. The final section of the report records the discussion of the lessons of the conference by some of those who attended it.

Laboratory Animals Bureau

The Laboratory Animals Bureau (Medical Research Council Laboratories, Holly Hill, Hampstead, London, N.W.3) is now issuing, on the fifteenth day of each month, a "Parade State" indicating what laboratory animals are currently available and from whom. The first of these publications was issued on January 15 and consists of five typewritten pages. It is divided into three sections—guinea pigs, mice and rabbits—and each section is further sub-divided into counties, under which are given the names and addresses of accredited breeders. Users who may have a surplus of any species are asked to notify the Bureau, preferably by the eighth of the month, so that the information can be included in the current "Parade State". The Bureau is holding its fifth Congress of Animal Technicians in the University of Cambridge during March 31–April 1. A number of lectures and discussions will be given in the Large Lecture Theatre, Department of Physiology, and at the same time there will be an exhibition of animal-house equipment in the Botany Laboratory of the School of Agriculture. The Congress is limited to animal and laboratory technicians only, and admission is by invitation. Further details can be obtained from the Laboratory Animals Bureau at the above address.

Summer School on the Healthy Family

A Summer School on "The Healthy Family", organized by the British Social Biology Council, will be held at Strasbourg, France, during August 6–20. The course is intended for teachers, nurses, health visitors, social workers and all who are interested in the family as the basic social unit and in the factors conducive to its physical, mental and spiritual health. The lecturers will include Dr. J. L. Burn, medical officer of health, Salford, and also a psychologist and a biology teacher. The names of these will be announced later. Students will be accommodated in single rooms in the University hostel, and meals will be served in the University restaurant. Strasbourg is not only a beautiful and historic city but is also a good centre for excursions, and students will be given ample opportunities both for personal exploration and for taking part in organized motor-coach tours of the Vosges and some of the picturesque towns and villages for which Alsace is noted. The cost of this School will be approximately £32, which includes registration, second-class travel from London and back, full board and lodging, and tuition. Further inquiries should be addressed to the Secretary, British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1.

Announcements

We regret to announce the death, on February 10, of Dr. H. D. Dakin, F.R.S., aged seventy-one.

The title of professor of biochemistry in the University of London has been conferred on Dr. W. T. J. Morgan in respect of the post held by him at the Lister Institute of Preventive Medicine. The degree of D.Sc. in the University has been awarded to Mrs. C. E. Work (Lister Institute of Preventive Medicine) and Mr. A. D. Booth (external student).

An advanced study course on the "Routine Dissemination of Information, and Abstracting" will be held by Aslib at 4 Palace Gate, London, W.8, during February 21–25. The course is for information officers and covers the ways in which such specialists can comb sources of information for items of particular interest to their organizations and how these items can best be presented and distributed. Further details of the course can be obtained from Aslib at the above address.

The Lalor Foundation, Inc., is offering two types of fellowship for work in the fields of chemistry and biochemistry, as follows. About six summer fellowships will be awarded for advanced research at the Marine Biological Laboratory, Woods Hole, Mass., on physiological chemistry, biochemistry or biophysics. The other awards consist of a series of predoctoral fellowships in the natural sciences with emphasis upon their biochemical and biophysical aspects, tenable at the University of Delaware, Harvard University, Johns Hopkins University, and the University of Pennsylvania. Further details can be obtained from the Foundation at Lancaster Pike and Old Baltimore Road, Wilmington, Delaware.

The Industrial Advisory Committee of the Ross Institute of Tropical Hygiene will hold a meeting in the Council Chamber of the Rubber Growers' Association, 19 Fenchurch Street, London, E.C.3, at 2.15 p.m. on February 21, open to all those interested in the health problems confronting industry in tropical countries; it is particularly hoped that representatives of mining companies and others connected with industries which operate in West Africa will be present. The subjects to be discussed are: the Ross Institute's programme of fundamental research on malaria control and its plans for the future; health problems in West African industry; and any other matter which may be brought to the notice of the Committee. Further particulars can be obtained from the Institute at Keppel Street (Gower Street), London, W.C.2.

ACCESSIBLE SURFACE AREAS OF COALS

THE accessible surface areas of bituminous coals lie in the range of 40–200 m.²/gm. when estimated from their methyl-alcohol adsorption isotherms or from heats of wetting in liquid methyl alcohol[1]. Recently, Lecky, Hall and Anderson[2] and Malherbe[3] have measured the surface by nitrogen or argon adsorption, using the Brunauer–Emmett–Teller method, and have obtained very much lower figures, in the range 0·4–11 m.²/gm., and Zwietering, Oele and van Krevelen[4] have confirmed these low figures. In explanation of the discrepancy, they have suggested that the polar nature of methyl alcohol and water enables these substances to penetrate regions of coal inaccessible to inert gases, that is, the apparent surface is in effect created by imbibition of the polar molecules leading to incipient peptization. Lecky, Hall and Anderson have drawn a parallel with the behaviour of polymers and proteins, and suggest that coals possess very little permanent internal surface.

The samples used and their method of preparation were substantially similar in all these investigations, and there can be little doubt that the almost hundredfold discrepancy between the two groups of surface area estimates is physically real, and does not arise from errors in interpretation (except, possibly, the neglect by Malherbe[3] of the prolonged uptake of argon and nitrogen), or the use of a restricted range of coals. The purpose of this and the following communication is to discuss the evidence in support of the higher values and the reason for so large a difference. Minor variations, such as those due to surface oxidation, will not be considered at this stage.

There are many reasons for believing that the interaction of methyl alcohol with coals is predominantly physical and non-specific in nature:

(1) Reproducible and definite figures, in the region of 5–20 per cent w/w, for saturation adsorption of methyl alcohol[1], water[5] and *n*-hexane[1] are obtained even on low-rank coals, which are the most reactive and polar in their nature. The polymers the behaviour of which was cited by Anderson *et al.*[2] lose their rigidity at high relative pressures, and tend, on the contrary, to yield very high values for the saturation adsorption.

(2) The surface area estimated by the Brunauer–Emmett–Teller method from the isotherm of *n*-hexane[1] on low-rank coal at 25° C. agreed closely with the figure obtained with methyl alcohol in spite of the non-polar nature of the hexane.

(3) The heat of wetting of low-rank coals in methyl alcohol is liberated in a few minutes, that is, as rapidly as the heat liberated when comparatively rigid adsorbents such as charcoal and carbon black are wetted; a slow peptization process is therefore unlikely to contribute appreciably to the value obtained.

(4) Bangham and Maggs[6] calculated an elastic modulus from the linear expansion of coal during adsorption of methyl alcohol and of hexane vapours. The figures obtained were nearly equal, and this result is consistent with their assumption that the expansion was a physical effect resulting from the lateral pressure of the adsorbed film.

(5) The value of the factor used for converting the heats of wetting in methyl alcohol to surface areas, 10 m.²/cal., was derived *for coal* by dividing areas estimated from methyl alcohol and hexane isotherms by the corresponding heats of wetting. Figures closely comparable with the value for low-rank coals have been obtained for carbon black[7], charcoal[8], graphite[1] and high-rank coals[1], all of which undergo but slight expansion on wetting and are unlikely to enter into a specifically polar interaction with methyl alcohol.

There is thus considerable evidence—neglected by those who take the view that the nitrogen adsorption area is correct—substantiating the higher values for the surface areas of coals. In the following communication further support for this view is given, and the possible reasons why low values might be obtained from nitrogen isotherms are discussed.

F. A. P. MAGGS

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Nov. 21.

[1] Griffith, M., and Hirst, W., Proc. Conf. Ultrafine Structure of Coals and Cokes, 80 (Brit. Coal. Util. Res. Assoc., 1944). Maggs, F. A. P., *J. Inst. Fuel*, **17**, 49 (1943).
[2] Lecky, J. A., Hall, W. K., and Anderson, R. B., *Nature*, **168**, 124 (1951).
[3] Malherbe, P. le R., *Fuel*, **30**, 97 (1951).
[4] Zwietering, P., Oele, A. P., and van Krevelen, D. W., *Fuel*, **30**, 203 (1951).
[5] Maggs, F. A. P., Bond, R. L., and Griffith, M., Disc. Faraday Soc., No. 3, 29 (1948).
[6] Bangham, D. H., and Maggs, F. A. P., see ref. 1, p. 118.
[7] Bond, R. L., and Maggs, F. A. P., *Fuel*, **28**, 169 (1949).
[8] Bangham, D. H., and Razouk, R. I., *Proc. Roy. Soc.*, A, **166**, 572 (1938).

COMPARISON of lump or particle densities of low-rank bituminous coals with densities measured by the displacement of the inert gas helium shows[1,2] that 10–15 per cent of the particle volume consists of pore space in the complete absence of swelling or peptizing action. If this porosity is compared with a typical surface area measured by low-temperature nitrogen or argon adsorption[3,4], then, whatever the shape of the pores, their average diameter must be in the region of 0·1 μ; and any appreciable volume of really fine pores would be incompatible with so high an average. This conclusion conflicts with the observation that coals act as molecular sieves[1], being in some cases impermeable to molecules only a few angstroms in diameter.

Recent studies of the mechanism of solvent extraction of coals[5] tentatively support the view[6] that there exist in low-rank bituminous coals compact units some hundreds of angstroms in diameter, surrounded by pores of much smaller diameter than above calculated, and giving coal an internal surface of the order of magnitude estimated from measurements with methyl alcohol[7].

Malherbe[4] showed that adsorption of argon was still proceeding after 1,500 hr.; but when plotting his isotherms he arbitrarily selected the period of 10 min., at the end of which the initial very rapid adsorption was complete. This procedure must have a considerable effect on the estimated areas. But a more important point seems to have been overlooked: with a thermolabile substance such as coal, measure-

ments made at a temperature some 200° C. lower than atmospheric are not necessarily comparable with those made at room temperature. It is possible, for example, that during thermal contraction pore constrictions might close to a greater proportionate extent than the rest of the structure, causing part of the internal surface area to become inaccessible to nitrogen, especially if the constrictions became blocked by adsorbed layers. The contrast between the rapid penetration by helium at room temperature[1] and the slow drift with argon[4] lends point to this remark; but density measurements with helium at −80° C. have failed to disclose an effect of this kind (helium is adsorbed at −196° C.). Temperature will also affect (perhaps greatly) the rate of penetration of pores of a given size by the adsorbed vapour.

Liquids of which the molecules possess a readily available lone pair of electrons on nitrogen or oxygen atoms are able to swell coal to a very great extent[5]. The heat of wetting in ethylene diamine, an outstanding example of this class of liquid, is much higher than the heat of wetting in methyl alcohol, and there is little doubt that this high value is related to the oxygen content of the coal[6]. Since methyl alcohol is also a member of the same class, although its electrons are much less available than those in ethylene diamine, this might be held to support the view of Anderson *et al.*[3]. But there is evidence that the difference in degree between these two liquids is so great as to amount to a difference in kind. For example, the isotherm[9] of ethylene diamine on low-rank coal rises rapidly and somewhat indefinitely as saturation is approached, whereas that for methyl alcohol[10] reaches a definite reproducible end-point. The heat of wetting of a charcoal was found to be the same in both liquids, so that their great difference in relation to low-rank coals seems to indicate that ethylene diamine interacts with these in a manner of which methyl alcohol is effectively incapable.

If methyl alcohol interacted to any considerable degree with the polar groups in coal, and (as postulated by Anderson) the sorption was of the same nature as imbibition by a polymer, it would be expected (1) that the heat of wetting divided by the amount adsorbed at saturation would be the same for different types of coal, and (2) that this quantity, for an open-structured coal penetrable by both liquids, would be considerably greater for methyl alcohol than for *n*-hexane. The accompanying table shows that this is not so.

It is possible that the particles observed by Nagelschmidt and Cartwright[12] in the electron microscope were produced by aggregation of molecules during the evaporation of the solution used; but when the close agreement with Kann's ultramicroscopic examination of similar solutions[13] is considered, there would appear to be strong evidence that such particles are present in the solution itself. They might be formed as loose aggregates in solution (a point now under investigation), and their presence is thus not necessarily incompatible with the view of coal structure and interaction with polar liquids favoured by Anderson *et al.*[3]. But the remarkable correspondence with the order of size required by the colloidal model of coal put forward by Bangham *et al.*[8] is of interest and possible significance.

Coal type	Sorbate	Heat of wetting (cal./gm.)	Amount adsorbed at sat. (gm./100 gm. coal)	Heat of wetting as cal./gm. sorbate
Northumberland weakly caking (−240 B.S.) (ref. 11)	Methyl alcohol	17·6	26	68
Northumberland weakly caking (−72 B.S.)	*n*-Hexane	5 (unpublished)	14 (ref. 10)	36
Yorkshire caking coal (−240 B.S.) (ref. 11)	Methyl alcohol	12·2	16	68
Welsh coking (−240 B.S.) (ref. 11)	Methyl alcohol	4·7	5	89

The conclusions of this and the preceding communication may be summarized as follows. There can be little doubt that permanent pores exist in coal, that there is a wide distribution of pore sizes, and that adsorption of inert gases at liquid-air temperature indicates a very much smaller surface area than adsorption and allied methods, whether using polar or non-polar substances, at room temperature. A likely explanation is the diminution of pore constriction sizes and rates of penetration by adsorbed gases when coal is cooled to liquid-air temperatures; but experimental proof of this is wanting. The crucial experiments have yet to be made.

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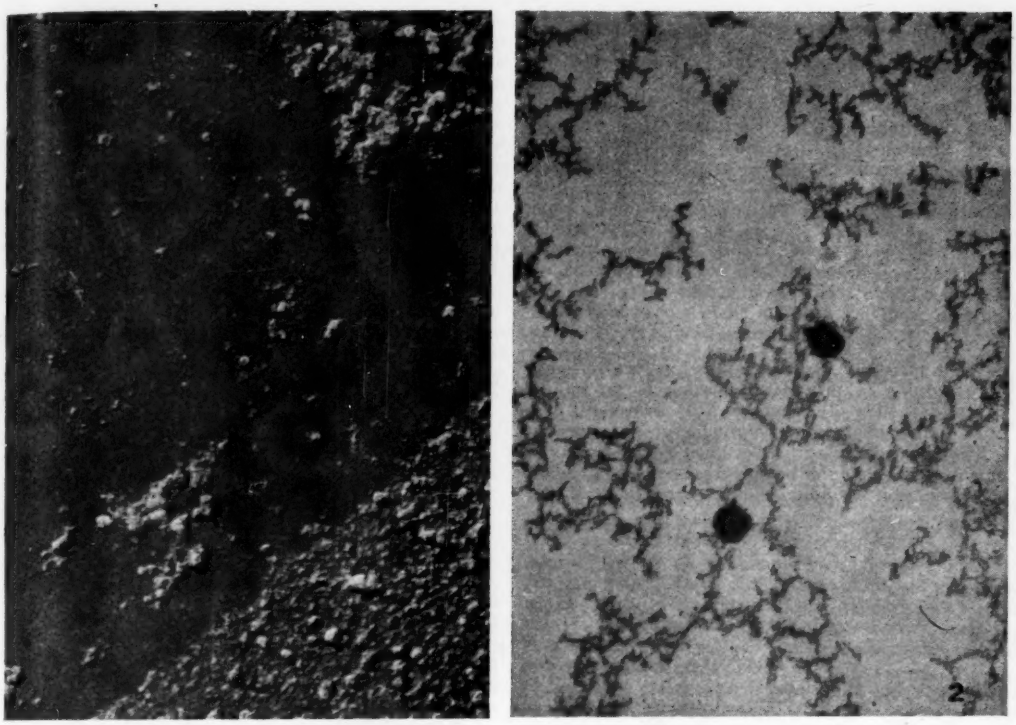
British Coal Utilisation Research Association,
Randalls Road,
Leatherhead, Surrey.
Nov. 21.

[1] Franklin, R. E., *Trans. Farad. Soc.*, **45**, 274 (1949).
[2] Zwietering, P., Oele, A. P., and van Krevelen, D. W., *Fuel*, **30**, 203 (1951).
[3] Lecky, J. A., Hall, W. K., and Anderson, R. B., *Nature*, **168**, 124 (1951).
[4] Malherbe, P. le R., *Fuel*, **30**, 97 (1951).
[5] Dryden, I. G. C., *Fuel*, **30**, 39, 145 (1951).
[6] Bangham, D. H., Franklin, R. E., Hirst, W., and Maggs, F. A. P., *Fuel*, **28**, 231 (1949).
[7] Griffith, M., and Hirst, W., Proc. Conf. Ultrafine Structure of Coals and Cokes, 80 (Brit. Coal Util. Res. Assoc., 1944).
[8] Dryden, I. G. C., and Bangham, D. H., *Fuel*, **29**, 291 (1950).
[9] Dresel, E. M., Dryden, I. G. C., and Farenden, P. J., *Research*, **4**, 579 (1951).
[10] Maggs, F. A. P., *J. Inst. Fuel*, **17**, 49 (1943).
[11] Dresel, E. M., Griffith, M., and Hirst, W., *Trans. Farad. Soc.*, **44**, 993 (1948).
[12] Nagelschmidt, G., and Cartwright, J. (letter following).
[13] Kann, L., *Fuel*, **30**, 47 (1951).

We have examined one of Dryden's samples of coal extract with an electron microscope. The extract solution had been prepared by shaking powdered Northumberland coal of low rank for fifteen minutes with anhydrous ethylene diamine at room temperature, and filtering through a No. 1 porosity sintered glass disk. The brown solution of extract contained about 3 per cent of dissolved material. After diluting about 10,000 times with water, samples were evaporated on thin 'Formvar' films and examined in an *E.M.*3 type electron microscope.

Fig. 1 shows a gold–palladium-shadowed specimen. Most of the particles seen are disks or spheres of 200–300 A. diameter. They are representative of the majority of the particles seen on ten different electron-microscope specimens examined. The range of sizes is roughly 150–800 A.

Fig. 2, which is unshadowed, shows a chain-like arrangement of these particles which is often, but not always, seen. Larger particles of the order of 0·1–0·3 micron diameter are also present; these may be aggregates or genuine particles which escaped filtration.



Ethylene diamine extract of coal. (1) Gold–palladium shadowed. × 40,000. (2) Unshadowed. × 30,000

The results obtained so far are in general agreement with the ultramicroscopic observations of Kann[1] on similar material.

G. Nagelschmidt
J. Cartwright
Safety in Mines Research Establishment,
Portobello Street,
Sheffield, 1.
Nov. 26.

[1] Kann, L., *Fuel*, **30**, 47 (1951).

A NEW PRINCIPLE FOR THE HISTOCHEMICAL LOCALIZATION OF HYDROLYTIC ENZYMES

By Dr. S. J. Holt
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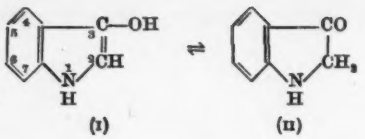
THE past twelve years have seen considerable effort directed to the development of methods for the visualization of the distribution of hydrolytic enzymes in animal tissues. Such methods have been based on the formation of coloured pigments or dyes: (*a*) after or (*b*) during the enzymic breakdown of a suitable substrate. In the first category are methods devised by Gomori for acid[1] and alkaline[2] phosphatase and for phosphoamidase[3], in which enzymically liberated phosphoric acid is precipitated as an insoluble salt, which is then converted into a coloured metal sulphide. Similar methods for the localization of other phosphatases have been described[4]. Allied methods based upon enzymic liberation of fatty acids have been developed for cholinesterase[5] and lipase[6], which are finally made visible as coloured metal sulphides derived from a suitable salt of the acid.

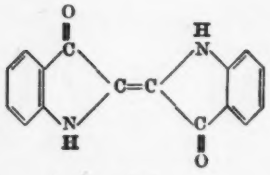
In the second category is a method originally introduced for alkaline phosphatase[7], in which naphthol, enzymically liberated from its phosphate, is converted into an azo-dye by the *in situ* action of a diazonium salt. This process has been developed and extended by Seligman *et al.* for the localization of acid[8] and alkaline[9] phosphatase, esterase[10], sulphatase[11] and glucuronidase[11], as well as for the colorimetric determination of these enzymes. Critical examination[12] of such methods has made it clear that the final picture obtained is governed not only by the initial distribution of the enzyme but also by many factors dependent on the complex processes employed, the properties of the enzyme and the specificity of the substrate.

During the past two years attempts have been made in this laboratory to overcome some of these factors by using substrates in which stain production spontaneously accompanies enzymic attack. The developing reagent is reduced to the simplest possible, namely, atmospheric or dissolved oxygen. Such substrates are derived from indoxyl, which exists as a tautomeric mixture of substances (I) and (II).

The equilibrium normally lies in favour of (II), which is rapidly oxidized by atmospheric oxygen to completely insoluble bright blue indigo (III). Indoxyl has two main reactive centres in the imino- and enol- groups, and substitution of hydrogen from



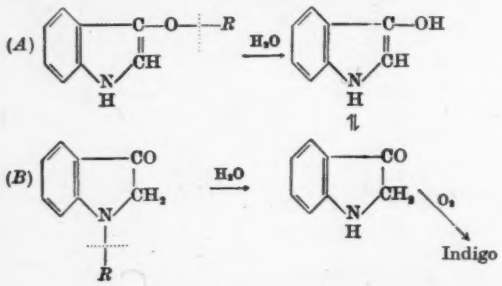
(I) (II)



(III)

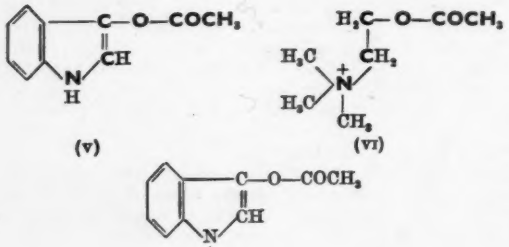
either centre (particularly by acyl groups) considerably reduces or prevents oxidation to an indigoid dye over a wide *p*H range (~ 5–9) for several hours at 37° unless another hydrolytic factor is also present.

The new principle thus becomes clear: hydrolytic enzymes catalysing either process *A* or *B* will induce the formation of indigo if air is present:

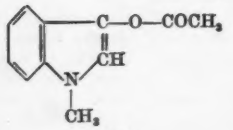


(IV)

When tissue sections containing enzyme are incubated in a buffered solution of an appropriate indoxyl derivative, they become rapidly and differentially stained by the deposition of indigo. The histochemically more important indoxyl compounds are those derived from the enol form (I). Of these, possibly the most interesting example is afforded by O-acetylindoxyl (V). Comparison of its formula with that of acetylcholine (VI) shows a significant skeletal resemblance:



(V) (VI)



(VII)

It has been amply shown[13] that the main requirements for a high rate of hydrolysis of an ester by specific cholinesterase are the possession of a small acyl group separated by a 2—C chain from another group such as $—NMe_3^+$, $—CMe_3$, etc. The presence of a quaternary nitrogen atom does not appear to be necessary. This is borne out by the rapid hydrolysis of (V) by specific cholinesterase with the simultaneous formation of indigo. As might be expected, the acetyl compound is also hydrolysed by non-specific cholinesterase. O-Acetyl-N-methylindoxyl (VII), which more closely resembles acetylcholine, is split at an even greater rate than the *nor* compound. In this case, however, oxidation of liberated N-methylindoxyl is complicated by extensive side-reactions, and formation of N : N′-dimethylindigo is far from quantitative. For this reason, (VII) is useless for histochemical purposes.

Kinetic studies have been made of the comparative rates of enzymic hydrolysis of O-acetyl-, O-propionyl-, O-butyryl-, O-benzoyl- and O-acetyl-N-methylindoxyls by specific and non-specific cholinesterases using the Warburg technique, modified to avoid absorption of oxygen by the indoxyl formed, which would otherwise interfere with the manometric readings. I am greatly indebted to Dr. Franz Hobbiger, Department of Pharmacology, Middlesex Hospital Medical School, for these results (see table).

Relative Rates of Hydrolysis of Substrates by Enzyme Preparations of Equal Activity to Acetylcholine

All substrate concentrations 4×10^{-3} *M* in 0·025 *M* bicarbonate containing 3·3 per cent ethyl alcohol (~ saturated).

Substrate	Specific esterase (human erythrocyte)	Non-specific esterase (human serum)
Acetylcholine	100	100
Acetyl-β-methylcholine	39	3
Benzoylcholine	2	116
O-Acetylindoxyl	60	23
O-Propionylindoxyl	41	63
O-Butyrylindoxyl	12	33
O-Benzoylindoxyl	0	3
O-Acetyl-N-methylindoxyl	72	123

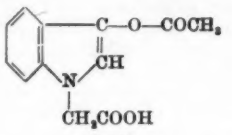
It is seen that the order of rates of hydrolysis of the indoxyl esters by the specific esterase is similar to that recorded[13] for the corresponding choline esters.

Indoxyl derivatives of the above type and others are being investigated, with special reference to the histochemical localization of cholinesterases in the central nervous system, by Prof. A. S. V. Burgen, of the Department of Physiology, McGill University, Montreal, with very encouraging results. It is hoped that the non-hydrolysis of O-benzoylindoxyl by specific cholinesterase may afford a direct method for differentiating between this and the non-specific enzyme, although the rate of hydrolysis by the latter is slow.

It thus seems that for cholinesterases a reasonable degree of specificity resides in the indoxyl moiety of compounds described above. When, however, the enol hydrogen atom is substituted by larger acyl groups or by completely different types, hydrolysis by cholinesterases becomes negligible and substrate specificity appears to reside in the oxygen-linked function. Even in the case of O-butyryl derivatives, incubation of pancreas sections in the presence of sufficient enzyme inhibitor to inactivate completely the cholinesterases produces strong staining, with a distribution of dye apparently identical with that obtained with similar sections using the Gomori lipase technique[6].

A difficulty experienced using simple indoxyl derivatives such as the above for tissue histochemistry is the character of the dye precipitate, which, for reasons not yet clear, tends to be deposited in granules or crystals. This may be overcome in principle by two main methods: (1) addition of

other substances to modify the crystal habit of the dye, (2) modification of the substrate molecule by substitution at a point or points *removed* from the site of enzymic attack. In the first case, it has been found by Burgen[14] that low concentrations of copper glycinate give a very marked improvement, probably by producing an amorphous chelate derivative of indigo. The second alternative may be approached by introducing into the benzene ring of the indoxyl molecule various heavy or polar groups tending to produce a more amorphous or less soluble dye. In this connexion, O-acyl derivatives of halogen, alkyl, alkoxy- and carboxy-indoxyls are being studied. Similarly, several O-acyl derivatives of N-carboxymethylindoxyl (for example, VIII) have been prepared; but although hydrolysis by esterases is facile in this case, oxidation of the liberated indoxyl compound to N : N′-dicarboxymethylindigo is wholly unsatisfactory under conditions appropriate to histochemical processes.

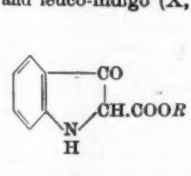


(VIII)

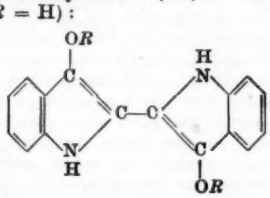
Further investigations in this laboratory are dealing with other derivatives of the enol (I) and allied compounds. Among these are the higher fatty-acid esters, phosphate, sulphate, glucoside and glucuronide; the enzymes involved being lipase, phosphatases, sulphatase, glucosidase and glucuronidase respectively.

Also derivable from indoxyls are N-substituted derivatives which it is hoped will undergo enzymic hydrolysis of type *B*. Thus compounds of type IV (R = —P.O(OH)$_2$) may afford substrates for phosphoamidase, while type (IV), where R is an appropriate amino-acid or short peptide chain, may serve for studies with aminopeptidases.

Two other colourless compounds readily transformed into indigo are indoxylic acid (IX, R = H) and leuco-indigo (X, R = H):



(IX)



(X)

The first readily decarboxylates to indoxyl, which then oxidizes to indigo, while the second rapidly oxidizes to this dye, from which it may be derived by reduction. Numerous attempts have been made in this laboratory to prepare compounds such as choline indoxylate (IX, R = $CH_2CH_2NMe_3^+$), but so far without success. This approach has not been abandoned, and it appears by analogy with the β-carbonaphthoxy derivative of choline recently described by Seligman[15] that the indoxylate would be hydrolysed only by non-specific cholinesterase. Indoxylic acid is, of course, an amino-acid, and appropriate peptides derived from it may serve as substrates for carboxypeptidases.

From leuco-indigo we have prepared the O : O′-diacetyl derivative (X, R = MeCO—) and also the corresponding O : O′-diacetyl-N : N′-dimethyl compound, both of which are resistant to hydrolysis by cholinesterases. This is probably due to gross steric effects; the compounds may each be regarded as containing two highly α substituted choline-like residues, which may resist enzymic hydrolysis of this type. While this work was in progress a report appeared[16] of the use of the disulphate ester of leuco-indigo (X, R = SO_3H) in a histochemical study of neoplastic tissue. Deposition of indigo was ascribed to the action of oxidases; I have not yet seen the original paper, but it would seem more reasonable to ascribe the result to sulphatase activity.

Two further points should be raised concerning these new chromogenic substrates. They also offer means of: (1) determining enzyme activity by colorimetric methods, an aspect which is being developed, and (2) investigating enzyme distribution in *living* organisms. Indoxyl compounds are relatively non-toxic, which is not surprising when the extensive occurrence of allied indole derivatives in Nature is recalled. Preliminary studies with small transparent organisms such as *Daphnia* show that indigo is deposited in the body of the animal when indoxyl compounds are included in its aqueous environment. Thus with O-butyrylindoxyl, the gut rapidly becomes stained by the dye. Extension to larger animals is fraught with obvious difficulties and would involve a study of the metabolism of the substrates by each species and dissection of the whole body; but this is an entirely new field for histochemistry which requires considerable development.

The indoxyl derivatives mentioned above have been synthesized in most cases from the corresponding phenylglycine-*o*-carboxylic acids, by cyclization with hot acetic anhydride to O : N-diacetylindoxyls[17]. These very stable, easily purified compounds are then deacetylated to the free indoxyls and converted into the required derivative by controlled acylation, etc. A very simple technique has been devised for carrying out these reactions in the absence of air; it will be described elsewhere.

Results of histochemical studies, carried out in collaboration with Mr. R. F. J. Withers, Biology Department, Middlesex Hospital Medical School, will also be reported elsewhere.

I wish to thank Prof. E. C. Dodds for his interest and encouragement.

Since this paper was written, Barrnett and Seligman[18] have described preliminary histochemical experiments using O-acetyl and O-butyryl indoxyls.

[1] Gomori, *Arch. Path.*, **32**, 189 (1941).
[2] Gomori, *Proc. Soc. Exp. Biol. Med.*, **42**, 23 (1939).
[3] Gomori, *Proc. Soc. Exp. Biol. Med.*, **69**, 407 (1948).
[4] Dempsey and Deane, *J. Cell. Comp. Physiol.*, **27**, 159 (1946). Dempsey and Wislocki, *Amer. J. Anat.*, **80**, 1 (1947). Glick and Fisher, *Arch. Biochem.*, **8**, 91 (1945). Krugelis, *Biol. Bull.*, **93**, 209, 215 (1947).
[5] Gomori, *Arch. Path.*, **41**, 121 (1946).
[6] Gomori, *Proc. Soc. Exp. Biol. Med.*, **68**, 354 (1948).
[7] Menten, Junge and Green, *J. Biol. Chem.*, **153**, 471 (1944).
[8] Seligman and Manheimer, *J. Nat. Cancer Inst.*, **9**, 427 (1949).
[9] Manheimer and Seligman, *J. Nat. Cancer Inst.*, **9**, 181 (1948).
[10] Nachlas and Seligman, *J. Nat. Cancer Inst.*, **9**, 415 (1949).
[11] Seligman *et al.*, *Ann. Surg.*, **130**, 333 (1949).
[12] Danielli, *J. Exp. Biol.*, **22**, 110 (1946); *Nature*, **157**, 755 (1946). Cleland, *Proc. Linnean Soc. N.S.W.*, **75**, 54 (1950). Novikoff, *Science*, **113**, 320 (1951). Gomori, *J. Lab. Clin. Med.*, **37**, 526 (1951). Glick, Engstrom and Malmstrom, *Science*, **114**, 253 (1951).
[13] Whittaker, *Physiol. Rev.*, **31**, 312 (1951).
[14] Burgen (private communication).
[15] Ravin, Tsou and Seligman, *J. Biol. Chem.*, **191**, 843 (1951).
[16] Sunder and Sunder, *Toulouse Méd.*, **50**, 127 (1950).
[17] "Friedländer", **5**, 940. Holt and Petrow, *J. Chem. Soc.*, 607 (1947).
[18] Barrnett and Seligman, *Science*, **114**, 579 (1951).

EDUCATION FOR MANAGEMENT

REPORT ON A VISIT TO THE UNITED STATES

THE Urwick Committee on Education for Management, reporting in 1947, recommended the appointment of a small, but authoritative, commission to examine and report on existing facilities for management education in the United States. More than twenty-five British productivity teams had, before the end of March 1951, almost unanimously attributed much of the drive for higher productivity per man-year, which they noted as characteristic of American business. to the attitude of the executives; and some teams traced a connexion between this attitude and a combination in the United States of facilities for higher education and strict adherence to promotion by merit. The Anglo-American Council on Productivity had already decided to send a number of teams dealing with educational problems, when the British Institute of Management suggested that yet another team should be sent to implement the recommendation of the Urwick Committee. This suggestion was accepted, and a report of the team's findings has now been published*.

The team was under the leadership of Colonel L. F. Urwick and consisted of fourteen members made up of the following types of person: chairmen or managing directors of undertakings of various types and sizes; educationists, including a representative of the Ministry of Education, specially concerned with administrative studies; managers having direct responsibility for training; and a representative of the trade union movement, selected by the British Institute of Management after consultation with various bodies. Its terms of reference required this team "To secure some measure of the volume of effort devoted to formal education in management subjects in the United States at all levels; to visit selected educational establishments providing formal schemes of education and training for management, and to study their methods; to attempt to assess the acceptability of such formal education in management subjects to industry and commerce and its influence on the subsequent careers of students".

During its forty days in the United States, members of the team visited thirty universities and colleges, seven other institutions, eight trade unions and fifty industrial and commercial undertakings. Full details are given in an appendix, and much of the general interest of this comparatively brief report is derived from the sixty-six pages appended to the twenty pages of the main report. These appendixes include, for example, a representative list of some four hundred persons who gave competent and responsible opinion on education for administration in discussion with members of the team; details of educational establishments in the United States which awarded degrees to students specializing in business or commerce in 1949–50; a glossary of American educational terms; statistics of university students enrolled and degrees granted; declared objectives of the Massachusetts Institute of Technology and other institutions providing teaching in administrative studies; descriptions of the Harvard Graduate School of Business Administration and of some undergraduate and graduate courses in administrative studies, as well as of courses for business executives and trade union officers, and of training schemes conducted by business. There are also collected extracts from reports of productivity teams which emphasize special characteristics of American managers that help productivity or which associate productivity-mindedness among American executives with provision for the education and development of future executives. This factual material is clearly presented so as to illustrate the general impressions summarized in the report in successive chapters on the American educational picture; education for business management; the schools of business administration; business and education; and executive development. Throughout, the report is admirably designed to serve the team's primary purpose of interpreting its experience in the United States in a manner which will help productivity in Britain.

The team believes that American experience has shown that productivity and education for management are closely related and that the whole question should be given further study in Britain. The findings of the team have been discussed in *Nature* of January 12, p. 43; here it need only be added that the team was profoundly impressed by the volume and variety of educational effort devoted to administrative studies which has been developed in the United States within half a century and mostly within the past thirty years; by the vigour, enthusiasm and sense of purpose which have accompanied this growth; and by the intellectual modesty with which the architects and leaders of this experiment regard their own handiwork.

* Productivity Report: Education for Management. Report of a Visit to the U.S.A. in 1951 of a Specialist Team concerned with Education for Management. Pp. xii+86. (Anglo-American Council on Productivity, 21 Tothill Street, London, S.W.1. 1951.) 4s. 6d.

PHYSIOLOGY OF MYXOMYCETES*

By Dr. LILIAN E. HAWKER
University of Bristol

THE study of Myxomycetes or Mycetozoa will always be associated with the name of Lister. The monograph on this group first published by Arthur Lister in 1894 [1] and afterwards revised by his daughter, the late Miss Gulielma Lister, is still the authority on the taxonomy and classification of these organisms and is a model of descriptive writing. The Listers, however, were also interested in the physiology of the slime moulds, including the effect of environment on spore germination, the feeding habits, the factors influencing formation of sporangia and the stimuli inducing and directing the amœboid movements of plasmodia and swarm cells. Their careful observations on these matters form the starting point for more recent work.

Observations on the factors influencing spore germination are scattered, incomplete and often contradictory. Nevertheless, it is clear that germination depends on both internal and external factors, as with germination of the spores of fungi. The degree of maturity of the spores is of importance. Many are unable to germinate immediately after formation, and, although they may remain viable for considerable periods, yet, in general, old spores germinate more slowly than young ones. Alternate wetting and drying was found by Lister to accelerate germination, and this has been confirmed by later

* Substance of the Lister Memorial Lecture delivered before the British Mycological Society on December 8, 1951.

observers. Spores of most species will germinate over fairly wide ranges of temperature (2°–36° C.) and of hydrogen ion concentration (*p*H 4·0–8·0), although the optimum values vary with the species.

Results obtained by different workers in experiments on the effect of nutrient solutions on germination are often contradictory. Many of these investigators took no particular care to exclude bacteria from their spore suspensions, and it has been shown that many species germinate more readily in the presence of suitable bacteria. Moreover, spores of *Reticularia lycoperdon* which fail to germinate in single-spore culture, germinate readily in the presence of other spores or in filtered liquid in which others have germinated. It is likely, therefore, that some growth-substance is required which is present in natural substrates or can be produced by certain bacteria and which does not normally reach a sufficiently high concentration in pure suspensions of only a few myxomycete spores.

Early workers recognized that solid food particles, such as cells of bacteria and yeasts, or certain fungal spores, are engulfed by both plasmodia and swarm cells and digested within the vacuoles. Unsuitable particles may be engulfed but are discharged unaltered.

Exact work on nutrition, however, has scarcely begun, since it is only comparatively recently that these organisms have been grown successfully in pure culture. Several successful attempts to grow them in 'two-membered' cultures, that is, in the presence of one other type of organism (bacterium, yeast or mould), have been made, among which that of Pinoy[2] is one of the earliest to be described. The important studies of Raper[3] on *Dictyostelium discoideum*, a member of the related group, Acrasiales, in which this organism was grown in 'two-membered' culture with various bacteria, have yielded interesting results. Raper has established that the initial composition of the medium influences the slime mould indirectly through influencing the bacteria on which it feeds. The maintenance of a suitably acid reaction is shown to be of importance. The true Myxomycetes have also been grown in 'two-membered' culture with other micro-organisms by a number of investigators. It is not until the work of Cohen[4], however, that we have a report of pure cultures which have successfully passed the stringent tests for purity which this author considered necessary. Cohen obtained pure cultures by migration of the plasmodia over a series of plates of plain agar or by transfer of the plasmodia to such plates after being allowed to feed on a suitable yeast colony when, in the absence of further food supply, the remaining yeast cells were consumed. The work of Sobels[5] is the first attempt to apply exact methods to the study of the nutrition of slime moulds. She showed that *Licea flexuosa* and some other species grew well in pure culture with an autoclaved suspension of the cells of certain yeasts or on gelatine to which peptone or asparagine were added. The addition of sugars (of which trehalose gave the best results) to an asparagine medium led to improved growth. Asparagine could not be replaced by ammonium salts.

The factors leading to a change from the active vegetative, or plasmodial, phase to the resting or sclerotial stage or to the initiation of spore production have not been precisely determined. Camp[6], however, showed that when *Physarum polycephalum* was grown on moist filter paper or gauze sprinkled with rolled oats, cessation of feeding led to sporulation. It is also clear, from the work of Raper[3] and others, that an acid reaction of the medium is essential for spore production.

The creeping movements of plasmodia and swarm cells are probably the result of a number of varied external stimuli, the relative importance of which has yet to be determined. Various observers have claimed, for example, that movement is controlled by light, gravity, temperature gradients, direction of flow of water or by gradients in moisture content and chemical composition of the substrates.

Thus it is clear that while advances have recently been made towards a clearer understanding of the relations between the slime moulds and their environment, much remains to be done. Moreover, the mechanism of the response of these organisms to environmental stimuli is entirely unknown. The study of the physiology of the Myxomycetes is a promising field for research, and investigations on the lines of those of Raper and Sobels would undoubtedly yield important results. A revival of interest in this subject would be the best memorial to the devoted work of the Listers, father and daughter.

[1] Lister, A., "The Mycetozoa" (London, 1894; 3rd edition 1925).
[2] Pinoy, E., *Ann. Inst. Pasteur*, **21**, 622, 686 (1907).
[3] Raper, K. B., *J. Agric. Res.*, **58**, 157 (1939).
[4] Cohen, A. L., *Bot. Gaz.*, **101**, 243 (1939).
[5] Sobels, J. C., thesis, Utrecht (1950).
[6] Camp, W. G., *Amer. J. Bot.*, **24**, 300 (1937).

MAN AND THE ZEBRA

THE past and present position of the zebra in Africa has recently been described by J. I. Menzies (*Oryx* (Journal of the Fauna Preservation Society), **1**, No. 3; September 1951).

Zebras include those species of Equidæ more or less marked with alternate dark and light bands, and fall into three groups. The first group is made up of two species, *Equus quagga* (the quagga) and *Equus burchelli* (Burchell's zebra). The second and third group each include only one species, *Equus zebra* (mountain zebra) and *Equus grevyi* (Grevy's zebra). Separate genera have been proposed for these species (*Hippotigris* and *Dolichohippus*); but these are usually regarded as sub-genera.

Equus quagga and *Equus burchelli* were both plains-dwelling species, often associating in immense herds with gnu and ostrich, but keeping separate in the overlapping portions of their ranges. Commencing with *Equus quagga* (striped only on the anterior portion of the body) and passing through the several sub-species of *Equus burchelli*, a gradual extension of the striping can be traced, culminating in the fully striped northern races.

The range of *Equus quagga* was fairly well defined, from the Kei River west at least as far as Swellendam and north to the Orange Free State and Griqualand West. *Equus burchelli* shows a great variation in striping; but, of all the numerous sub-species that have been proposed, only four are recognized as valid. The southernmost is *Equus burchelli burchelli*, which was found in the Orange Free State and Southern Bechuanaland but not south of the Orange River. The whole of the body was striped but not the legs, the haunch being more or less distinctly marked. Towards the posterior, broad shadow stripes appear between the dark stripes. The second sub-species is

antiquorum, with the legs incompletely striped and the shadow stripes less distinct than in *burchelli*. This race once inhabited Southern Angola, South-West Africa, eastwards to Southern Rhodesia and Zululand.

The last two sub-species, *selousii* and *böhmi*, are fully striped to the hooves with the shadow stripes indistinct or altogether absent. They range from the Limpopo northwards, east of the Rift Valley through Rhodesia, the Congo (Katanga and Ruanda), Nyasaland, Tanganyika, Kenya and Uganda, to Abyssinia and Somaliland.

The second group of zebras (mountain zebras) includes only one species, *Equus zebra*, completely striped with broad black bands. Two sub-species are recognized. *Equus zebra zebra* had a limited range in the mountains of the Cape Colony. *Equus zebra hartmannæ* is now greatly restricted, but was formerly found in South-West Africa along the sub-continuous chain of arid mountains bordering the western edge of the Namib desert. Frequently found on the seashore, it often occurred up to 7,000 ft. and was rarely seen more than thirty miles inland. It ranged from Southern Angola across the Orange River to the Kamiesberg. Both sub-species associated only in small parties.

The third group (Grevy's zebra) also includes only one species, *Equus grevyi*. This became known to science as late as 1882, although the Romans had zebras which may have been of this species. These zebras appear to inhabit open, sparsely-wooded country, avoiding thick bush, and are rather localized throughout Southern Abyssinia and Western Somaliland. Southwards they range into Kenya to the Tana River, westwards to Lake Rudolph and eastwards to the western border of Somaliland. They do not appear to occur farther north than lat. 8°. The species appears to be fairly numerous over its original range and is in no danger of extinction. Of the other two groups, one species (*Equus quagga*) and one sub-species (*Equus b. burchelli*) are extinct and another (*Equus z. zebra*) brought to the verge of extinction.

Being the most southerly of the zebras, *Equus quagga* was the first to suffer from the advance of civilization. Initially, quaggas existed in countless thousands, until the Boers began their systematic exploitation. By the first quarter of the nineteenth century the former herds of thousands had been reduced to herds of thirty to fifty animals. By 1840 they had been driven to the borders of the Cape Colony. North of the Orange River, however, they were still numerous; but exploitation for their hides continued. In addition, the farmers found the beasts a ready source of cheap meat for their native labour. The last two quaggas in the Cape Colony appear to have been shot on the Tygerberg Mountain, near Aberdeen, in 1850. Quaggas still lingered on, however, in the Orange Free State, possibly as late as 1878.

Several times quaggas have been reported from the Kaokoveld, South-West Africa, but this is almost certainly due to confusion with Hartmann's zebra.

The history of *Equus b. burchelli* followed a similar course. It once existed in immense herds, "but all have long ago been swept away by the rifle". Like its relative south of the Orange, this species provided a cheap supply of meat for the native labour of the progressing colonists.

The other three sub-species of *Equus burchelli* are still numerous; in some parts the numbers have to be kept under control to avoid damage to crops. In South-West Africa *antiquorum* is common and far outnumbers *hartmannæ*. Some have adapted themselves to the mountain ranges of South-West Africa, occurring alongside but not associating with *hartmannæ*.

Farther to the north and east the races *selousii* and *böhmi* are still found. Where there is little cultivated land they are in no danger of reduction and in the various national parks and reserves provide one of the greatest attractions.

Equus zebra, with its two sub-species, *zebra* and *hartmannæ*, was always a more specialized animal with a very restricted range. With the quagga, the Cape race was early subjected to the onslaught of the colonists, but owing to its inaccessible habitat was not so seriously affected. As did the quagga, it provided cheap meat and leather for the farmers. By 1935 it was estimated that only a hundred were left alive. The species was then accorded complete protection; but the numbers were still reduced by poachers.

In 1937 the Government voted a sum of £7,600 for the establishment of a reserve to the west of Cradock. By 1949 the stock in the reserve was reduced to two stallions, which have since died. More recently, a new herd has been located in the Outeniqua mountains, and it was suggested that a new reserve be established there. The sum total at that time was between seventy and a hundred. In September 1950, this new reserve was opened and enriched by the generous gift of eleven animals from an African farmer. It is hoped that the future of the mountain zebra is now secure.

THERMAL SWITCH FOR THE ATTAINMENT OF VERY LOW TEMPERATURES

In a recent issue of the *Proceedings of the Physical Society**, workers at the Clarendon Laboratory, Oxford, described how, by an ingenious method employing a superconducting lead wire as thermal switch in a two-stage adiabatic demagnetization process in which a magnetic field of only 9,000 gauss was used, they have been able to attain an absolute temperature of approximately 0·001° K. and to hold the temperature of the system below 0·01° K. for forty minutes.

In the adiabatic demagnetization method of cooling, the magnetization is usually carried out at a temperature of about 1° K., the lowest temperature attainable by pumping liquid helium. Large water-cooled magnets are required to produce the necessary field, but the use of such large fields can be avoided by using a two-stage process in which the second-stage magnetization is effected at the lower temperature, less than 1° K., reached by the first-stage demagnetization. It is necessary, however, to have a means of making and breaking the thermal contact between the two stages. E. Mendoza, in 1948, used a piece of copper foil which was broken mechanically after magnetization of the second stage, but his apparatus suffered from very rapid reheating of the second stage.

The Oxford method is to use two cylinders of compressed salt, the upper and larger of iron ammonium alum, and the lower a dilute mixture of crystals of potassium aluminium alum and potassium chrome alum, as the two stages, connected by a lead wire

* Darby, J., *et al.*, *Proc. Phys. Soc.*, A, **64**, 861 (1951).

of the highest purity and about 3 cm. long. This wire is the thermal switch between the two stages. With both stages magnetized, thermally isolated from the surroundings and at 1° K., the magnet was lowered slowly so that the upper stage was demagnetized while the lower stage remained in the field. The lead wire, being still in a field greater than its threshold value, remained a good thermal conductor, and heat was transferred from the lower to the upper stage. With the magnet lowered still further so that only the lower stage was in the field and any stray field around the lead wire carefully reduced to zero, the lower stage was more or less thermally isolated from the upper, because the lead wire was superconducting and thus of considerably reduced thermal conductivity. Removal of the magnet demagnetized the lower salt and the temperature fell to the order of 0·001° K. The residual heat inflow of the apparatus after demagnetization is stated to be about 1 erg/min.

The possibility of adapting the superconducting switch to control the flow of heat between the nuclear and electronic stages in the proposed combined use of nuclear and electron paramagnetism, so as to extend the lower limit of temperature attainable, is also briefly discussed in the article.

REPRODUCTION OF THE TUBERCLE BACILLUS

A COLLOQUIUM upon "Reproduction of the Tubercle Bacillus" was held in Cambridge on December 8, 1951, at the Cavendish Laboratory, continuing in the afternoon at the Strangeways Laboratory. The meeting was sponsored by Dr. E. M. Brieger, of Papworth Hospital, near Cambridge.

The introductory address was given by Dr. K. A. Bisset, who stressed the complexity of structure of the organism and of its modes of reproduction. These appearances are often unrecognized, because of the practice of examining only well-grown cultures, and then almost exclusively by means of techniques which reveal only acid-fast stages. Dr. Bisset also suggested that it is important to try to make certain to which of the many known types of growth and reproductive activity a particular phenomenon belongs before attempting to complete its interpretation.

The relationships between mycobacteria and other Actinomycetes was indicated by E. O. Morris, who showed that many of the complex reproductive processes described in *M. tuberculosis* are quite commonly found in these apparently allied forms. He especially emphasized germination of the resting stages by means of germ tubes as characteristic of the entire group.

Dr. V. E. Cosslett demonstrated the work, which had been performed in collaboration with Dr. Brieger and Miss A. M. Glauert, upon the electron microscopy of various stages in the life-history of *M. tuberculosis*. Early cultures of an avian strain consisted of short rods which, after forty-eight hours, began to be replaced by larger, beaded filaments, and were again restored, in the later stages of culture, to the original form. Granular forms of bovine bacilli isolated from infected rabbit tissues were also examined. The larger granules, 0·5–1 μ in diameter, appeared to contain rod-like bacterial elements; this material proved to be highly infectious to guinea pigs.

A substantial degree of correlation between the interpretation of electron, phase-contrast and classical microscopy seems now to have been achieved, although the density of the putative structures, and especially of the nucleus, to the electron beam appears to vary, both relatively and absolutely, at different stages of growth. It was also pointed out, by Dr. Bisset and Mr. Morris, that many structures, especially septa and cross-walls, can be demonstrated only irregularly by the electron microscope, but are regular features of the organism as seen in stained preparations. Dr. Cosslett agreed.

Dr. C. H. Lack described some of the appearances which can be seen in synovial fluid from tuberculous joints. Acid-fast and non-acid-fast granules were seen. Slide cultures, examined stained and by phase-contrast microscopy, showed many of the forms reported in life-cycle studies by earlier workers, including 'cocci' and tetrads. 'Cocci' were observed to germinate. A syncytial stage was also observed, in which numerous nuclei were embedded in a sheet of cytoplasm. The granular forms infected guinea pigs only exceptionally, and the coccal and syncytial stages from culture gave no allergic response and were apparently non-infective, but produced splenic enlargement and marked wasting.

In the afternoon Dr. E. M. Brieger and Miss A. M. Glauert showed a series of lantern slides of their preparations of growing cultures of different types of *M. tuberculosis*. Dr. Brieger demonstrated that by the use of nigrosin as a counter-stain, the derivation of acid-fast colonies from non-acid-fast mycelial structures could be followed in avian strains. Mr. Morris commented upon the possibility that these represented primary and secondary mycelia, as in Actinomycetes and Streptomyces. Miss Glauert described similar results obtained using the phase-contrast microscope to study living cultures of avian bacilli, growing on embryo-extract–chick-plasma clots. Two main types of micro-colony were seen developing from mycelia: serpentine 'cords' of bacilli, and irregular, spherical 'hedgehogs'. Both types eventually became acid-fast although they developed from mycelia which were mainly non-acid-fast. Dr. Brieger also reported that somewhat similar results had been obtained with a bovine strain which had been injected into the intra-amniotic fluid of the egg. In response to a query, he stated that he had not separated these types and consequently had not attempted to isolate a cord factor, although the strain was highly virulent.

Reference was made by Dr. Honor B. Fell to previous warm-stage observations of living avian bacilli, when the drawings made during continuous observation of the same field showed the peculiarities of the two types of development, the bacillary and the mycelial type.

Dr. E. Klieneberger-Nobel was requested to give her views upon the relationship between the *L*-form in other bacteria and the granular symplasms of *M. tuberculosis*. She gave an account of the phenomenon in various bacteria, and emphasized that it frequently appeared as a reaction to an unfavourable environment.

There was much general discussion, in an informal atmosphere. An impression was achieved that much had been done to correlate the views of workers in the physical, biological and medical fields of this problem, and that the area of agreement was both surprisingly and satisfactorily wide.

LETTERS TO THE EDITORS

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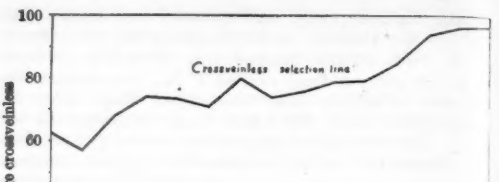
Selection of the Genetic Basis for an Acquired Character

There are so many examples of the adaptation of an animal to its environment which at first sight would appear to find their simplest explanation in the supposition that the effects of the environment have become inherited, that theories of this kind have continued to retain a following in spite of the lack of clear experimental evidence in their support. This following has been composed mainly of naturalists; experimentalists and geneticists have recently tended to adopt an attitude similar to that expressed by Dobzhansky[1], who writes: "This question has been discussed almost *ad nauseam* in the old biological literature . . . so that we may refrain from the discussion of it altogether". In dismissing the matter so cavalierly, Dobzhansky was explicitly referring to "direct adaptation", that is, the hypothesis that when the environment produces an alteration in the development of an animal, it simultaneously causes a change in its hereditary qualities such that the developmental alteration tends to be inherited. It has been usual, indeed, to consider this suggestion as the only possible alternative to the opposed view that environmental effects have no hereditary consequences, the phenomena of adaptation being solely due to the natural selection of chance variants.

Recent work, however, suggests another alternative. We know that environmental stimuli may produce developmental abnormalities (phenocopies) which simulate the effects of mutant genes; and a perusal of the scattered literature on the subject suggests that there is a good deal of variation among normal stocks in their sensitivity to the external stimuli. I therefore suggested some years ago[2] that all the necessary machinery is available by which a genetic basis could be, and in the course of natural selection would be, set up to reproduce any given environmental effect which was of value to the animal concerned. Natural selection will act, not solely on fortuitous variants resembling the form produced by the environment, but on the sensitivity of normal individuals to the environmental stimulus; and the genotypes sensitive to the external influence will also reinforce the action of any genes which tend to produce similar phenotypes and will canalize their activity towards the exact effect which is being selected for.

In a recent experiment, this possibility has been actually realized. Individuals of a wild-type strain of *Drosophila melanogaster* were given a strong environmental stimulus by submission to a temperature of 40° C. for four hours at an age of 17–23 hr. (in later generations 21–23 hr.) after puparium formation. A crossveinless phenocopy was produced with a frequency of about 40 per cent. Two selection lines were set up, in one of which the flies which showed the phenocopy were bred from in each generation, while, in the other, selection was against phenocopy formation. Fairly rapid changes were produced in both directions, particularly from the fifth generation onwards, at which time it was realized that the critical period for the effect was at the 21–23 hr. stage, to which the treatment was thereafter confined (see graph).



Progress of selection for and against the formation of the crossveinless phenocopy, from the fifth generation onwards, the temperature shock being applied to pupæ aged 21–23 hr.

The important point is that from the twelfth generation onwards of the stock selected for sensitivity, flies showing the crossveinless phenotype began to appear even among those individuals which had not been given the temperature treatment. Matings between these have given rise to strains which regularly produce crossveinless flies when cultured at normal temperatures. During the course of selection, a genetic constitution has therefore been synthesized which under normal conditions produces the same effect as was originally found only as a response to the stimulus of an abnormal environment. This genetic constitution is not, in the present stocks, fully penetrant, the frequency of crossveinless in the various strains reared at normal temperature never surpassing about 80 per cent; but there is no reason to suppose that further selection will not elicit a fully penetrant strain.

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[1] Dobzhansky, Th., "Genetics and the Origin of Species" (Columbia Univ. Press, 1937).
[2] Waddington, C. H., *Nature*, 150, 563 (1942).

Breakage of Chromosomes Produced by Ultra-violet Radiation in *Drosophila*

In *Drosophila melanogaster*, ultra-violet radiation produces genetic mutations, both lethal and visible, among which the frequency of chromosome aberrations is very low[1]. In this respect, genetic changes induced by ultra-violet radiation resemble spontaneous changes, in striking contrast to those produced by ionizing radiations or, to a lesser degree, by the mustard group of chemicals.

The experiments of one of us (Fabergé[2] and unpub.) with *Zea mays* show that in this material ultra-violet radiation produces chromosome breaks at a very high frequency, but that a very high proportion of these breaks are restored and so remain undetected unless special means are used for their detection. A critical experiment in this connexion has been performed by Schultz[3]. We wish to present here data showing that, in *Drosophila melanogaster* also, ultra-violet radiation produces numerous chromosome breaks followed by restitution.

It is known that if males carrying a ring *X*-chromosome are irradiated with X-rays and mated to normal females, there will be a deficiency of daughters among the offspring[4]. A ring chromosome, after being broken, will probably be restored so that at the next cell division it will form a double-size dicentric ring instead of two daughter rings. This is formally analogous to the formation of a Möbius strip, and such a dicentric ring acts as a dominant lethal to the female offspring that receive it.

We have made similar experiments with ultra-violet radiation. Males carrying the X^{C2} ring were irradiated using a method adapted from that of Kaufmann and Hollaender[5], the abdomens of males being pressed into a layer 0·15 mm. thick between quartz plates. The radiation used was that from a Westinghouse *WL782H* 'Sterilamp', a low-pressure mercury discharge the active component of which is almost entirely 2537 A. Total radiation delivered at the location of the flies was at a rate of 24,600 ergs cm.$^{-2}$ sec.$^{-1}$. Immediately after treatment, each male was mated to three females. The results are summarized in Table 1.

Table 1

Exposure (min.)	No. of X^{C2} males tested	Offspring Females	Offspring Males	% Females	t	P
5; 10; 15 (results pooled)	41	5,156	5,095	50·12	3·586	10^{-3}–10^{-4}
Control	52	6,585	5,782	53·15		
10	37	3,167	3,032	50·94	3·973	10^{-4}–10^{-5}
Control	31	4,723	3,843	55·13		

That ordinary rod *X*-chromosomes are not subject to the same effect is shown by a trial in which wild-type Canton males were irradiated (Table 2).

Table 2

Exposure (min.)	No. of wild type males tested	Offspring Females	Offspring Males	% Females	t	P
10	19	1,592	1,576	50·02	0·725	0·4–0·5
Control	36	3,566	3,678	49·09		

The fiducial limits of this last experiment exclude the possibility of a difference as large as 2·5 per cent at the 0·05 level of probability. A 10-min. exposure represents a dose of $1{\cdot}48 \times 10^7$ ergs cm.$^{-2}$, and under our conditions about 24 per cent of treated males produced offspring after such a dose. All treated males died within a few days, at the most one week, after exposure. The sex ratio in the controls depends on the particular female stock used, which differed in the separate experiments.

Because of the occurrence of statistical heterogeneity in such data, the tests of significance are made by calculating an empirical variance, using the proportion of females from each treated male as the variate. This variate was not weighted, on account of considerations discussed by Cochran[6].

There is no very adequate basis for estimating the proportion of dicentric formation following breakage of ring chromosomes, but a value of the order of 0·5 does not seem unreasonable. The overall 3 or 4 per cent change in sex ratio therefore means that roughly twice that percentage of ring *X*-chromosomes are broken by the ultra-violet treatment. The production of chromosome breaks by ultra-violet radiation, always or nearly always followed by restitution, was expected and looked for in *Drosophila* because of results obtained with *Zea*. It seems reasonable, therefore, to expect that this will prove to be characteristic of the genetic effects of ultra-violet radiation in general. Details of these experiments will be published elsewhere.

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[1] Altenburg, E., *Amer. Nat.*, **68**, 1491 (1934). MacKenzie, K., and Muller, H. J., *Proc. Roy. Soc.*, B, **139**, 491 (1940). Demerec, M., Hollaender, A., Houlahan, M. B., and Bishop, M., *Genetics*, **27**, 139 (1942). McQuate, J. T., *Genetics*, **35**, 680 (1950). Valencia, J. I., and McQuate, J. T., *Rec. Genet. Soc. Amer.*, **20**, 128 (1951).
[2] Fabergé, A. C., *Rec. Genet. Soc. Amer.*, **20**, 97 (1951).
[3] Schultz, J., *Proc. U.S. Nat. Acad. Sci.*, **37**, 590 (1951).
[4] Bauer, H., *Naturwiss.*, **49**, 821 (1939). Pontecorvo, G., *J. Genet.*, **41**, 195 (1941).
[5] Kaufmann, B. P., and Hollaender, A., *Genetics*, **31**, 368 (1946).
[6] Cochran, W. G., *J. Amer. Statis. Assoc.*, **38**, 287 (1943).

Protandry with Self-Fertilization in the American Slipper Limpet, *Crepidula fornicata*

The American slipper limpet, *Crepidula fornicata*, which is a protandric hermaphrodite mollusc[1] usually occurring in piles or chains of two to as many as nineteen individuals, and where the older individuals in the chain are female and the younger top ones male, has recently[2] frequently been found solitary and in spawn in deep water in Lyme Bay, from off Sidmouth to off Slapton.

In this new locality of its distribution, there has not been enough time and opportunity for young individuals to settle on older ones in all cases, to form the usual chains. But as the solitary slipper limpets were taken in the trawl, it is impossible to state with certainty that little ones (males) have not been brushed off the larger solitary females. There is virtual certainty in many cases[3] that the individuals taken singly and in spawn had lived a solitary life and were therefore self-fertilized from a previous male phase; but since the animals were not collected from the ground without disturbance, the certainty had to remain virtual until the opportunity occurred of collecting solitary individuals by hand. That opportunity has now occurred. While investigating an island exposed at low water neaps, about three-quarters of a mile above Shaldon Bridge in the Teignmouth estuary, a few solitary *Crepidula* were taken on the common mussel on a mussel bed. One of these slipper limpets had recently deposited newly laid spawn (June 6) which, on examination in the Plymouth Laboratory, was found—and demonstrated to a meeting of south country naturalists—to con-

tain ciliated revolving (yellow) larvæ. There was no indication on the shell of this slipper limpet that a young individual (therefore a male) had ever rested there, nor was there any indication that a young individual could have lived on the mussel itself. Moreover, less than a dozen *Crepidula* were taken in searching the mussel beds (several thousand individuals) at low water on three spring tides, so that as yet *Crepidula* is rare in this locality. Thus the virtual certainty that *Crepidula fornicata* will spawn as a female and produce larvæ when living in a solitary state after settlement is now found to be reinforced by direct observations of limpets seen *in situ* where they have originally settled. It is still desirable, however, that isolated individuals should be reared experimentally in the sea to the state of fruitful femaleness without contact with males to establish with certainty the occurrence of protandry with initial self-fertilization.

In the earlier studies on the age of sex-change in *Crepidula*[3] the possibility of self-fertilization of the female by its own sperm at its first female phase was conceived but rejected, because of the presence of young males on a continuous surface on the same experimental raft. In the larger and older individuals copulation occurs normally, and reproduction is presumably always bisexual.

As sexual phenomena seem to be identical or very similar in the genus *Crepidula*[4], it is not unlikely that self-fertile protandry may be found to occur in young isolated forms in all species.

It is an interesting fact that Hsiao[5] has shown that *Limacina* passes from a young male through a functionally bisexual to a final female phase, a condition comparable to that cited above for isolated young *Crepidula fornicata*. I have also suggested that the type of oyster represented by the European species, *Ostrea edulis*, may on suitable occasions utilize the sperm of a male phase to fertilize the eggs of an ensuing female state.

The possibility of a phase of self-fertility in a single individual of a species which produces free-swimming larvæ is highly significant for the speed of the extension of the geographical distribution of this species, since a new batch of larvæ can be liberated into the water a few years after reaching the limit of an earlier extension[2,6].

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[1] Orton, J. H., *Proc. Roy. Soc.*, B, **81**, 468 (1909).
[2] Orton, J. H., *Proc. Mal. Soc.*, **28**, 182 (1950).
[3] Orton, J. H., *J. Mar. Biol. Assoc.*, **10**, 322 (1914).
[4] Coe, W. R., *J. Exp. Zool.*, **108**, 168 (1948).
[5] Hsiao, S. C., *Biol. Bull.*, **76**, 280 (1939).
[6] Crisp, D. J., *Nature*, **166**, 311 (1950).

Sexual Behaviour of *Anopheles fluviatilis* in Captivity

The procedure adopted with regard to the raising of a colony of *A. fluviatilis* and its maintenance in the laboratory has already been described[1]. Swarming and mating were induced by the use of artificial blue light directed inside the cage.

In the course of subsequent studies, additional information was obtained concerning the sexual behaviour of this species in captivity. In warmer environment, *A. fluviatilis* was observed to respond (swarming and mating) to the stimulus provided not only by blue light but also by ordinary light, and even in darkness. Two colonies of this mosquito were established in the same type of colony cages (2 ft. × 2 ft. × 2 ft.), in one of which white light was provided and the other in which the use of light, blue or white, was altogether dispensed with. Both these colonies were established with eggs obtained from wild-caught females.

Mosquitoes in a buoyant condition could be induced to swarm and pair even after midnight both by blue and white light. Since differential sexual behaviour by the different races of *Anopheles* species has been found to be of extreme value, it is felt that the above results may be useful in differentiating the biological races of *A. fluviatilis* in places where it is a malaria-carrier and in places where it does not transmit the disease. A fuller account of this work will be published elsewhere.

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[1] Mohan, B. N., *J. Mal. Inst. Ind.*, **6**, 1, 75 (1945).

Growth in the Laboratory of Economically Important Oribatid Mites

Recent quantitative analyses of the microfauna of the soil have shown that oribatid mites are by far the largest representatives. Their economic value is well known; they carry the infective stages of anoplocephaline cestodes, some of which are important parasites of sheep. Attention has recently been directed to their role in the promotion of humus formation from leaf litter on the forest floor, and at the same time it was pointed out that little was known of the biology of these mites[1].

About a year ago I completed investigations on the growth of the oribatid mite *Scheloribates lævigatus* Koch, during the course of which a technique was evolved for successfully rearing them. The mites were reared from egg to adult in a modified form of filter-paper cell[2] (the intermediate layer of filter paper, which lined the cavity of the cell, was omitted).

The best results were obtained when the mites were kept in darkness at 25° C., 100 per cent relative humidity and fed on chicken fæces. These conditions are most favourable for egg production; exposure to light had a decidedly inhibitory effect. Although all stages fed on the tissues of either fresh or decayed moss, this diet did not appear to promote egg production and the materials became, in fact, valuable only for providing sites for oviposition.

The primary stages in the life-cycle are the egg, larva, three nymphal stages and the adult. Each post-embryonic stage is regarded as having a developmental phase (for example, pre-nymph and pre-adult) and a mobile growing phase[3]. The duration of the developmental phase of each stage of *S. lævigatus* varies little. On the other hand, the duration of the mobile growing phase of each stage varies considerably owing to the fluctuation in time of the period from the moment the mite emerges to the commencement of regular feeding. The duration of this regular feeding period of any particular stage is fairly constant for different individuals. This feeding behaviour is not unlike that of some ectoparasites,

for example, the tick or the harvest mite, which must of necessity wait for an indeterminate period of time before an opportunity for regular feeding arises; in such cases the duration of the actual feeding period is fairly constant.

The accompanying table shows the shortest, longest and mean durations of the various stages in the life-cycle of *S. lævigatus* based on the rearing of 125 individuals.

DURATION OF STAGES IN THE LIFE-CYCLE OF *S. lævigatus* AT 25° C., 100 PER CENT RELATIVE HUMIDITY

Stage	No. of individuals	Duration in days		
		Minimum	Maximum	Mean
Egg	83	5	14	8
Larva	13	7	17	10
Pre-protonymph	12	2	4	3
Protonymph	9	4	64	11
Pre-deutonymph	11	2	5	3
Deutonymph	18	4	37	10
Pre-tritonymph	12	2	4	3
Tritonymph	9	5	30	12
Pre-adult	6	3	4	4

The shortest time which a single individual took to complete its life-cycle was 42 days; the longest was 115 days. When kept at the temperature of the laboratory, oribatid mites may take a year or more to complete their life-cycle from the egg to the adult[4].

These results are part of work on the growth of oribatid mites carried out in the Department of Zoology, University of Edinburgh. I hope to publish a full account of my investigations elsewhere.

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[1] Report on Forestry Research for the Year ending March 1950 (H.M. Stationery Office, 1951).
[2] Jones, B. M., *Nature*, **166**, 823 (1950).
[3] Jones, B. M. (private communication).
[4] Michael, A. D., "British Oribatidæ" (Ray Society, London, 1883).

High Blood Potassium in Insects in Relation to Nerve Conduction

THE analyses of Bishop[1], Boné[2], Brecher[3], Drilhon[4], Tobias[5], and others show that in phytophagous insects the potassium concentration in the hæmolymph is always high and exceeds 70 m*M*/litre in some instances. Such values would depolarize vertebrate or crustacean nerve fibres and stop conduction[6]. Insect nerves may have different properties in regard to potassium, or this may be bound in some way to the organic constituents of the blood. Alternatively[7], the fibres may be protected from the high blood potassium by a sheath capable of ionic regulation, providing the axons with a local environment containing a lower potassium concentration than that of the blood.

Insect peripheral nerves are surrounded by a sheath which consists of a homogeneous non-cellular layer, the neural lamella, beneath which there are arranged nuclei dispersed at regular intervals, embedded in a thin continuous cylindrical sheet of cytoplasm (Fig. 1, *cf.* ref. 7). The direct effect of potassium on the axons and the role of this sheath have been investigated in nerves of the phytophagous insect *Locusta migratoria* L. A diagram of the preparation is shown in Fig. 2. Crural nerves were exposed *in situ* and a single motor fibre was stimulated antidromically in a distal branch. Recordings

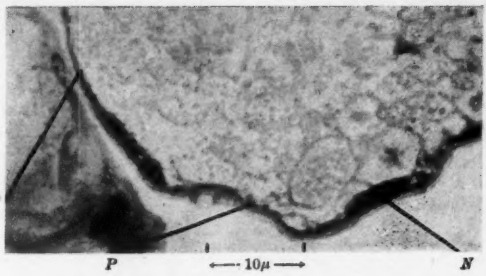

Fig. 1. Part of transverse section of crural nerve of *Locusta migratoria*, showing neural lamella with underlying cytoplasmic cylinder or perilemma (*P*), with associated nuclei (*N*). The section also includes fine tracheoles embedded in a thin membrane surrounding the neural lamella

were made of the action potential using a silver hook electrode placed under the exposed crural nerve as shown. The exposed nerve was bathed in salines containing up to 70 m*M* potassium ions per litre. These salines failed to affect the action potential over several hours in good preparations. Higher concentrations gradually reduced the size of the action potential; a concentration of 140 m*M* blocked conduction after two to three hours. Saline containing five times the potassium concentration of sea water (about 50 m*M* potassium ions per litre) blocks crustacean nerves in about a minute[6].

Salines were injected under the sheath with a micropipette which was introduced at the point shown in Fig. 2. Concentrations of 40 m*M* potassium ions or more cause a rapid block in conduction when introduced in this way. If very small quantities are injected, the block builds up gradually as the saline diffuses to the active fibre. As it diffuses farther along the nerve and mixes with the fluid normally present under the sheath, the local concentration of potassium falls again towards its original value and the block in conduction is removed. These changes are illustrated in Fig. 3, which shows action potentials at various intervals after the injection of a small volume of saline containing 70 m*M* potassium ions per litre. A few seconds after introducing the saline a partial block is apparent by the delay of the second phase. After about 10 sec., the local block is complete and the action potential becomes monophasic. About 30 sec. later, partial recovery has occurred, as shown by the reappearance of a delayed second phase. After about 100 sec., the action potential is almost normal again. The same sequence is followed when a further similar volume of the saline is introduced, showing that recovery is not due to some form of adaptation. In control experiments using a concentration of 5 m*M* potassium ions per litre the action potential remains unaffected.

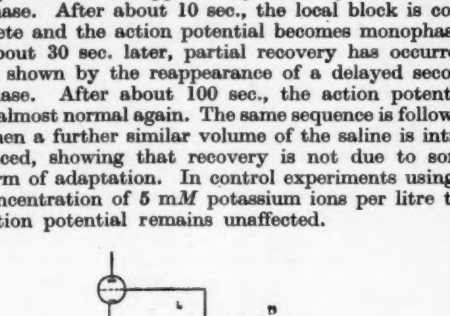

Fig. 2. Diagram of the preparation, showing point of insertion of the micropipette

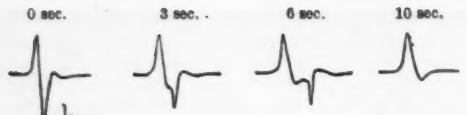

Fig. 3. Tracings from a photographic record of single-fibre action potentials after injecting a small volume of 70 m*M* potassium saline

From these results it seems that insect nerve axons are affected by potassium in a similar way to vertebrate and crustacean axons, and that the sheath surrounding them protects the axons against a high level of potassium in the surrounding body fluid.

I wish to thank Dr. B. Katz, Mr. J. W. S. Pringle and Dr. G. P. Wells for helpful advice and criticism.

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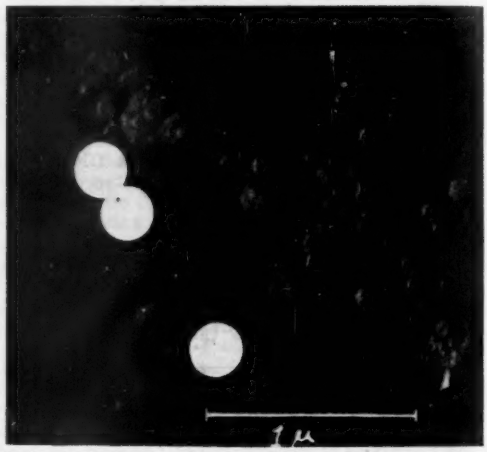
[1] Bishop, G. H., *J. Biol. Chem.*, **66**, 77 (1926).
[2] Boné, G. J., *Ann. Soc. Roy. Zool. Belg.*, **75**, 123 (1944).
[3] Brecher, L., *Biochem. Z.*, **211-2**, 40 (1929).
[4] Drilhon, A., *C.R. Soc. Biol., Paris*, **115**, 1195 (1934).
[5] Tobias, J. M., *J. Cell. and Comp. Physiol.*, **31**, 143 (1948).
[6] Cowan, S. L., *Proc. Roy. Soc.*, B, **115**, 216 (1934).
[7] Pringle, J. W. S. (personal communication).

Chromatophores of *Rhodospirillum rubrum*

The pigments of photosynthetic bacteria are not localized in chloroplasts, and appear upon microscopic examination to be evenly distributed throughout the cell. It has long been known that the absorption maxima of the bacteriochlorophyll and carotenoid pigments are markedly shifted following extraction with organic solvents—a fact first interpreted by Lubimenko[1] as evidence that these pigments exist in chemical combination with proteins within the intact cell. About ten years ago, this interpretation received further support from the work of Katz and Wassink[2] and of French[3,4], who found that aqueous extracts of the pigments with unaltered absorption maxima could be prepared by mechanical disintegration of the cells; French[4] also observed that the entire pigment-complex in such extracts could be precipitated with ammonium sulphate.

In the course of a study of the macromolecular composition of bacterial extracts, we investigated one photosynthetic species, *Rhodospirillum rubrum*. Cells were grown in the light, harvested by centrifugation, disrupted by grinding with alumina as described by McIlwain[5], and extracted with 0·02 *M* sodium chloride, after which the alumina, coarse debris and unbroken cells were removed by centrifugation for ten minutes at 7,000 r.p.m. The resulting extract, which was dark red in colour and showed an intense Tyndall effect, was examined in a Spinco ultracentrifuge equipped with a Philpot–Svensson optical system. All the pigment in the extract proved to be associated with particles of very great size, which sedimented far more rapidly than any other component (sedimentation constant approximately 190 *S*). It was then found that the pigment-bearing particles could be sedimented satisfactorily in the high-speed head of an International refrigerated centrifuge, operated at 20,000 r.p.m. for approximately an hour. Freed of smaller components by repeated washing in this manner with 0·02 *M* sodium chloride, the particles show a single rather diffuse sedimentation boundary, coinciding with the colour boundary, when examined in the ultracentrifuge. Electron micrographs of this washed material reveal greatly flattened, disk-shaped structures (see photograph) with an apparent diameter of approximately 1100 A. On the assumption that the particles were originally spherical and become flattened during drying, we can calculate an equivalent spherical diameter of 600 A., which checks reasonably well with the minimal value of 400 A. calculated from the sedimentation data. Their weight is approximately 30 million times that of the hydrogen atom.



Electron micrograph of the washed chromatophores from *Rhodospirillum rubrum*. The large white spheres are polystyrene particles with a diameter of 2600 A.

The absorption spectrum of the purified particles in the visible and near infra-red regions is virtually identical with that of the intact cells, if allowance is made for the difference in degree of scattering; it shows the characteristic maxima of bacteriochlorophyll at 880, 805 and 590 mμ and of the carotenoids at 545, 505 and 480 mμ. Chemical analysis reveals the presence of protein and of a small amount of pentose nucleic acid, but no deoxypentose nucleic acid.

For technical reasons it is not easy to measure the number of particles per cell with accuracy; determinations by two independent methods gave values of 5,000 and 6,000, but these figures may well be in error by a factor of two.

Rhodospirillum rubrum is a facultative phototroph, and can be grown aerobically in the dark on suitable organic substrates[6]. Under these conditions, the cells become almost completely bleached[6]. Extracts prepared from such dark-grown cells do not show a sedimentation boundary in the ultracentrifuge corresponding to that of the pigment-bearing particles.

It thus appears that growth in the dark causes a great diminution in the number of these particles, as well as a cessation of pigment synthesis.

Our observations show that the photosynthetic pigments of *Rhodospirillum rubrum* exist not merely in chemical combination with cell proteins, but also associated with particulate structures the size of which is enormous on a molecular scale. These particles must be the site of the primary photochemical reaction in bacterial photosynthesis. Since they do not possess the structural complexity of typical chloroplasts, it seems most appropriate to designate them as 'chromatophores'.

We wish to thank Dr. Robley C. Williams for taking the accompanying electron micrograph.

Details of this work will be published elsewhere[7].

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[1] Lubimenko, V., *J. Soc. Botan. Russie*, **6**, 107 (1921).
[2] Katz, E., and Wassink, E. C., *Enzymologia*, **7**, 97 (1939).
[3] French, C. S., *J. Gen. Physiol.*, **23**, 469 (1940).
[4] French, C. S., *J. Gen. Physiol.*, **23**, 483 (1940).
[5] McIlwain, H., *J. Gen. Microbiol.*, **2**, 288 (1948).
[6] van Niel, C. B., *Bact. Revs.*, **8**, 1 (1944).
[7] Schachman, H. K., Pardee, A. B., and Stanier, R. Y., *Arch. Biochem. Biophys.* (in the press).

Reaction of Penicillin with the Staphylococcal Cell Wall

IT has been demonstrated previously[1-3] that contact between resting sensitive staphylococci and penicillin results in a small firmly-bound uptake of the drug by the bacteria. When washed suspensions of *Staphylococcus aureus* with radioactive penicillin attached were ruptured by shaking with fine glass beads, subsequent radiometric assay of the deposit and supernatant after centrifuging suggested that the penicillin had been concentrated within the cytoplasm of the cell[4]. However, when unlabelled organisms were disrupted by the same method, it was found in a large number of experiments that while very little, if any, of the penicillin-binding capacity of the intact cell could be detected in the non-dialysable fraction of the cytoplasm, a larger percentage was frequently found in the cell-wall fraction than could be accounted for by the few intact bacteria present.

In view of the fact that the cell-wall preparations obtained might have been chemically or mechanically degraded from their natural state in the whole organisms, conditions of rupture were sought which would minimize such degradative changes.

A sensitive strain of *Staphylococcus aureus* was either grown overnight in a tryptic digest broth containing 0·01 u./ml. of radiopenicillin, or the washed untreated organisms were suspended in a phosphate buffer solution of 0·4 u./ml. radiopenicillin at *p*H 6·5 for half an hour. After washing free from excess penicillin in the centrifuge, the organisms were then resuspended to 2 mgm./ml. in an aqueous solution half-saturated with octyl alcohol containing 0·5 per cent tri-sodium citrate, 1 per cent (v/v) commercial formalin and 0·1 per cent (v/v) thioglycollic acid, and adjusted to *p*H 6·5; 20-ml. samples of the bacterial suspensions were put with 20 gm. of glass ballotini beads (*c.* 0·2 mm. diameter) in stoppered 'Pyrex' containers and the air displaced by passage of nitrogen for ten minutes. The cells were disrupted at 6° C. by agitating the tubes on a 'Microid' shaker at a constant speed of 40 vibrations per second until the number of whole bacteria present was less than 2 per cent (about twenty minutes). Care was taken not to shake longer than was necessary, so that mechanical degradation of the cell walls was minimized; and all subsequent operations were performed as rapidly as possible at 6° C. The suspension was then separated into supernatant and deposit fractions in the centrifuge and both fractions were assayed for radioactivity.

Under these conditions, most of the radioactivity was found attached to the cell-wall material (Table 1). When the penicillin uptake was increased by overnight growth in sub-inhibitory concentrations, the radioactivity still remained on the cell wall.

Table 1. DISTRIBUTION OF RADIOACTIVITY AFTER RUPTURE OF *Staph. aureus* TREATED WITH RADIOPENICILLIN IN THE SHAKING MIXTURE DESCRIBED IN THE TEXT

Bacterial preparation	Penicillin attached before rupture (u./gm.dry wt.)	Radioactivity remaining attached to cell-wall preparation (%)
Bacteria grown in medium containing 0·01 u./ml. radiopenicillin, washed 3 times with distilled water	4·2 4·3 4·5	96 88 95
Bacteria suspended in 0·4 u./ml. radiopenicillin, washed three times with distilled water	2·6 2·6 2·3	93 82 72

Staphylococci were also ruptured in the shaking medium described above before treatment with radiopenicillin, again as rapidly as possible. This cell-wall material was found to bind penicillin as strongly as did the intact bacteria, giving an uptake which was two to three times greater than that of the whole bacteria when assayed on a dry-weight basis (Table 2).

Table 2. UPTAKE OF PENICILLIN ON A CELL-WALL PREPARATION COMPARED WITH INTACT ORGANISMS FROM THE SAME BATCH. One half of a *Staph. aureus* suspension in the shaking medium described in the text was ruptured, and both samples were then centrifuged and washed twice in distilled water before addition to penicillin. This treatment had no effect on the uptake of penicillin on intact organisms

Radiopenicillin concentration (u./ml.)	Uptake on whole bacteria (u./gm.)	Uptake on cell-wall preparation (u./gm.)
0·5	2·4	4·8
1·0	2·3	5·1
1·5	2·6	5·2
2·0	2·8	5·4

Whatever shaking conditions were employed, the penicillin-binding component was not detected in the non-dialysable fraction of the cytoplasm by the use of an electrodialysis method for removing unbound penicillin[5].

It appears, therefore, that penicillin reacts with a component which is present in the cell wall of the bacterium. This component, and its complex with penicillin, is easily destroyed or dissociated from the cell wall and rendered soluble on rupture of the organism, but its removal can be largely prevented by agents which are known to inhibit certain chemical changes. It is evident, however, that even under these conditions the changes are not completely

inhibited, as variable amounts (4–30 per cent) of the radioactivity were found in the supernatant after rupture of organisms treated with radiopenicillin, and 25–40 per cent of the penicillin-binding component of untreated cells was destroyed or rendered soluble.

It is interesting that some of the metabolic changes which occur most rapidly after contact with penicillin in a growing medium appear to be concerned with cell-wall phenomena[6–10].

We are indebted to Dr. C. E. Challice, of the National Institute for Medical Research, Mill Hill, for his kindness in taking electron micrographs. One of us (P. D. C.) wishes to acknowledge a grant from the London University Central Research Fund for apparatus.

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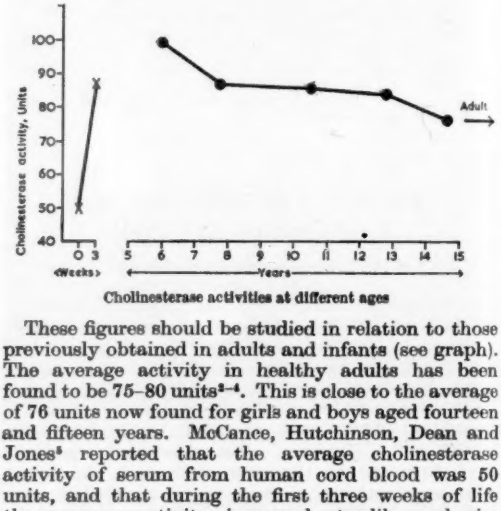
[1] Cooper, P. D., and Rowley, D., *Nature*, **163**, 480 (1949).
[2] Rowley, D., Cooper, P. D., Roberts, P. W., and Lester Smith, E., *Biochem. J.*, **46**, 157 (1950).
[3] Maas, E. A., and Johnson, M. J., *J. Bact.*, **57**, 415 (1949).
[4] Cooper, P. D., Rowley, D., and Dawson, I. M., *Nature*, **164**, 842 (1949).
[5] Few, A. V., Cooper, P. D., and Rowley, D., *Biochem. J.* (in the press).
[6] Mitchell, P., and Moyle, J., *Nature*, **166**, 218 (1950).
[7] McQuillen, K., *Biochim. Biophys. Acta*, **6**, 534 (1950–51).
[8] Gale, E. F., and Taylor, E. S., *J. Gen. Microbiol.*, **1**, 314 (1947).
[9] Gale, E. F., and Rodwell, A. W., *J. Gen. Microbiol.*, **3**, 127 (1949).
[10] Mitchell, P., and Moyle, J., *J. Gen. Microbiol.*, **5**, 421 (1951).

Cholinesterase Activities in the Serum of Healthy British Children

In the course of some work which was being done in Germany on the effect of a liberal diet on the serum cholinesterase levels in under-nourished children[1], it was realized that there were no corresponding figures for healthy, well-nourished children available for comparison. It was therefore decided to measure the pseudo-cholinesterase activity of the serum of normal girls and boys. Blood was taken from 111 healthy children attending schools in Cambridge. These children were all between five and fifteen years old and so far as possible each year of age was represented by five girls and five boys. Preliminary experiments had shown that the activities of sera from blood obtained by ear puncture did not differ significantly from the serum activities in the same subjects when the blood was taken by venepuncture. Blood samples, therefore, were obtained by puncturing the lobe of the ear with a piece of capillary tubing and allowing the blood to fall directly into an agglutination tube, which was then quickly closed with a rubber stopper. The serum was separated in the usual way. Cholinesterase determinations were carried out in duplicate in a Warburg apparatus by the method used by McArdle[2], with acetylcholine chloride as substrate. Activities were expressed in c.mm. carbon dioxide/ml. serum/min.

The averaged results for girls and boys, divided into five age-groups, are shown in the accompanying table. From the age of five to fifteen years the serum activities of both the girls and the boys decreased progressively. The average activity of the sera from the girls aged five to six years was significantly different from the activity of the sera from girls aged fourteen and fifteen years ($t = 2{\cdot}97$, $p = < 0{\cdot}01$). The difference between the corresponding values for the boys' sera was also significant ($t = 2{\cdot}78$, $p = 0{\cdot}02$).

The activity of single sera varied from 50 to 136 units. The average serum activity of the girls of all ages was 85 units, and of the boys 87 units. This difference was not statistically significant; but throughout the age-range studied the average activities of sera from the boys tended to be higher than the average activities of sera from girls of the same age. It is possible that the difference between girls and boys might have been significant had larger numbers of children been examined.



Cholinesterase activities at different ages

These figures should be studied in relation to those previously obtained in adults and infants (see graph). The average activity in healthy adults has been found to be 75–80 units[2–4]. This is close to the average of 76 units now found for girls and boys aged fourteen and fifteen years. McCance, Hutchinson, Dean and Jones[5] reported that the average cholinesterase activity of serum from human cord blood was 50 units, and that during the first three weeks of life the average activity increased steadily and significantly to 87 units. The average activity of serum from healthy children aged five and six years has now been found to be 100 units. It is therefore apparent that the increase which takes place during the first three weeks of life probably continues. It is possible that the average activity of 100 units observed in the five- and six-year-old children may be the highest level reached; but it is equally likely that at some age between three weeks and five years the serum cholinesterase activity may average considerably more than this. A study of children from three weeks to five years of age is now being made in order to settle this point.

Cholinesterase Activities in the Serum of Girls and Boys

	Girls					Boys				
Average age (years and months)	6.0	7.10	10.6	12.11	14.7	6.0	7.11	10.6	12.9	14.7
No. of children	9	10	15	9	10	10	12	15	12	9
Average cholinesterase activity	99	85	85	82	75	100	89	85	85	77
Standard deviation	20	17	13	10	15	16	11	13	15	18

We wish to thank the School Medical Officer of Cambridge, the heads of the schools, the parents and the children for allowing us to make this investigation.

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[1] McCance, R. A., and Widdowson, E. M. (in the press).
[2] McArdle, B., *Quart. J. Med.*, N.S., **9**, 107 (1940).
[3] McCance, R. A., Widdowson, E. M., and Hutchinson, A. O., *Nature*, **161**, 56 (1948).
[4] Hutchinson, A. O., McCance, R. A., and Widdowson, E. M., Spec. Rep. Ser. Med. Res. Coun. No. 275, p. 216 (1951).
[5] McCance, R. A., Hutchinson, A. O., Dean, R. F. A., and Jones, P. E. H., *Biochem. J.*, **45**, 493 (1949).

Nitrate Reductase Activity during the Embryonal Development of the Frog

IN 1938, Yamagata suggested that the nitrate reductase which reduces nitrate to nitrite participates in some bacterial respiration[1]. Recently, the mechanism of nitrate reductase and nitrate respiration has been investigated in bacteria and rat liver by Egami and his group[2], but frog liver was found not to contain this enzyme[3].

We have investigated the nitrate reductase in the period of embryonal development of the frog (*Rhacophorus schlegelii arborea*). At the same time, other enzyme (succinic and lactic dehydrogenase) activities were estimated by the triphenyl tetrazolium chloride method[4].

Experiment 1. Estimation of the nitrate reductase activity. Twenty-five eggs or tadpoles at each stage from blastula to tadpole (1 cm. length) were homogenized and diluted to 2 c.c. with distilled water. In this homogenate, 1 c.c. of 0·1 *M* phosphate buffer (*p*H 7·4), 0·5 c.c. of 0·2 *M* sodium succinate (as hydrogen donator) and 1 c.c. of 0·01 *M* potassium nitrate were added. Incubations were carried out anaerobically at 37° C. using Thunberg tubes for 2·5 hr. After incubating and removing protein, the activity was estimated by determining the appearance of nitrite colorimetrically with Griess–Ilosvay reagent.

Experiment 2. Estimation of succinic and lactic dehydrogenase activities. In the same homogenate mentioned above, 0·5 c.c. of 0·1 *M* phosphate buffer (*p*H 7·4), 1 c.c. of 0·2 per cent triphenyl tetrazolium chloride and 0·5 c.c. of 0·2 *M* sodium succinate (in the case of succinic dehydrogenase) or 0·5 c.c. of 0·2 *M* sodium lactate containing 20 per cent of hydroxylamine hydrochloride as ketone-fixative[5] (in the case of lactic dehydrogenase) were added. Incubations were carried out anaerobically at 37° C. for 2 hr. using Thunberg tubes. After incubating, 0·5 c.c. of 20 per cent trichloroacetic acid and 8 c.c. of ethyl acetate were added with vigorous stirring and the mixture centrifuged. The activities were estimated by determining colorimetrically the appearance of formazan in the portion of ethyl acetate.

Experiments 1 and 2 were carried out under sterile conditions.

Our results, which are given graphically in Figs. 1 and 2, show that at the beginning of development lactic dehydrogenase activity, which was increasing gradually before hatching, decreased rapidly at hatching, and was similar to the curve for lactic acid production[4]; at the same time, at the beginning of development succinic dehydrogenase activity was lower than lactic dehydrogenase activity, but rapidly became stronger and after hatching its activity was dominant. On the other hand, the nitrate reductase had maximum activity at hatching, but the activity decreased rapidly with increase of melanin and activation of blood circulation (increase of hæmoglobin).

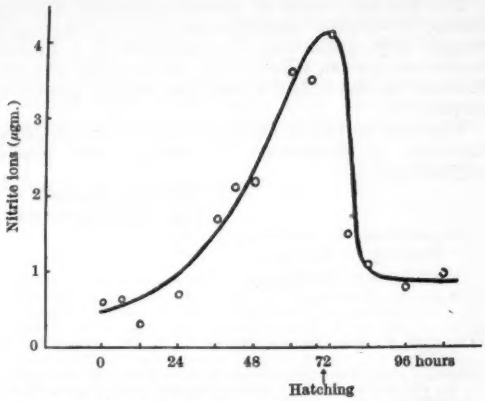
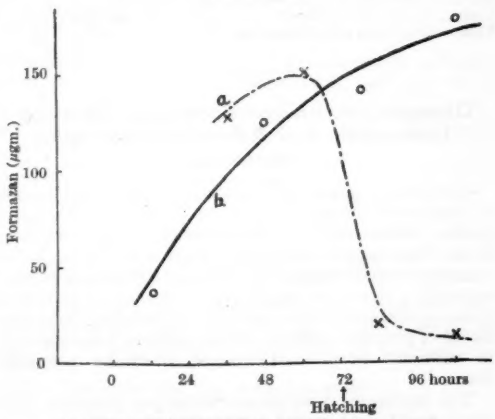


Fig. 1. Nitrate reductase activity during embryonal development of the frog



(*a*) Lactic dehydrogenase; (*b*) succinic dehydrogenase

Fig. 2. Lactic and succinic dehydrogenase activities measured by the triphenyl tetrazolium chloride method during the embryonal development of the frog

NITROGEN DIOXIDE PRODUCED BY THE NITRATE REDUCTASE DURING EMBRYONAL DEVELOPMENT OF THE FROG

Unit: μgm. Material: 25 eggs or tadpoles

Stage	Blast.		Gast.		Neur.		Tail-bud			Hatching	Tadpole			
hr.	0	6	12	24	36	42	48	60	66	72	78	84	96	108
Exp. No. 1	0·58	0·62	0·30	0·69	1·7	2·1	2·1	3·8	3·5	4·0	1·6	1·2	0·9	1·1
Exp. No. 2	0·61	0·65	—	0·73	1·8	—	2·4	3·7	3·2	4·1	1·6	1·3	0·9	0·9
Exp. No. 3	0·60	0·62	—	0·71	1·7	—	2·2	3·5	3·7	4·1	1·4	0·9	0·6	1·2
Average	0·60	0·63	0·30	0·71	1·7	2·1	2·2	3·6	3·5	4·1	1·5	1·1	0·8	1·0

The humped curve of nitrate reductase activity during ontogenetic development of the frog might suggest phylogenetically the existence of a nitrate respiration period, which would be supposed to come between the fermentation and the aerobic period of respiration.

We wish to thank Dr. R. Sato, of the Chemical Institute of Kanazawa University, for helpful suggestions.

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[1] Yamagata, S., *Acta Phytochimica (Japan)*, **10**, 283 (1938); **11**, 145 (1939).
[2] Egami, F., and Sato, R., *Nippon Kagaku-kai-shi*, **68**, 39 (1947); **69**, 160 (1948); **70**, 297 (1949); *Bull. Chem. Soc. Japan*, **22**, 137 (1949).
[3] Sato, R. (personal communication).
[4] Kun, E., and Abood, L. G., *Science*, **109**, 144 (1949).
[5] Green, D. E., and Brosteaux, J., *Biochem. J.*, **30**, 1489 (1936).
[6] Brachet, J., *Arch. Biol. (Paris)*, **45**, 611 (1934).

Observations on the Connexion between Intermedin and Adrenocorticotropic Hormone

Cutaneous pigmentations similar to those found in Addison's disease have been described after prolonged treatment with adrenocorticotropic hormone. It has been suggested that such pigmentation might be caused by an admixture of the pituitary melanophore-expanding hormone intermedin. We have therefore tried to determine the amount of intermedin in the blood of patients suffering from Addison's disease and in different adrenocorticotropic hormone preparations.

The injection of adrenocorticotropic hormone into the dorsal lymph sac of a frog (*Rana temporaria*) that has been adapted to light produces the same reaction as intermedin. As small an amount as 1/20,000 I.U. of the hormone still gives a clearly visible expansion of the melanophores, and the degree of expansion is independent of varying content of vasopressin or oxytocin in the preparations. Control experiments on hypophysectomized animals or with isolated skin samples have given the same results.

No difference was found in the properties of adrenocorticotropic hormone and intermedin when both were isolated from the pituitary glands of cattle and pigs. Both hormones are similarly affected by a number of substances; thus both are inactivated by nitrite, formaldehyde, trypsin and homogenates of liver, kidney and adrenal.

A peptide that gives the adrenocorticotropic activity was prepared by Li's method by hydrolysis of adrenocorticotropic hormone with pepsin and final separation from inactive components by paper chromatography. It shows the same activity when tested on the melanophores as it does when tested by Sayers's method. The biologically inactive components were also inactive in the melanophore test.

Intermedin was tested by paper chromatography using phenol – water as solvent. It gave only one spot, which had the same biological activity and R_F value as the adrenocorticotropic hormone peptides.

The effect on a normal human of a hormone fraction from the pituitary prepared by the technique used for the isolation of intermedin was observed. This intermedin was administered in daily doses corresponding to 20 mgm. of adrenocorticotropic hormone, in a single dose on the first day and in four doses of 5 mgm. during the two following days; this intermedin preparation was tested by the frog's melanophore test. After administration of intermedin, corresponding to 20 mgm. adrenocorticotropic hormone, the eosinophil leucocytes decreased from 376 per c.mm. to 127 per c.mm. (66 per cent). The corticoids in the urine rose from an initial value of 0·4 mgm./24 hr. to 1·1 mgm./24 hr. and the potassium excretion in the urine increased more than 100 per cent (from 74 mgm. to 218 mgm.). There was, however, no significant increase in the excretion of 17-ketosteroids. The test was repeated with corresponding doses of adrenocorticotropic hormone. It was found that even then there was no increase in the excretion of 17-ketosteroids, and the corticoids rose from 0·6 mgm. only to 0·9 mgm. during administration of this hormone.

Serum from fifteen normal persons and from five patients with cutaneous pigmentation but with a normally functioning adrenal cortex (according to the adrenocorticotropic hormone test) had no melanophore-expanding effect. Serum from five of six patients with Addison's disease caused a marked melanophore expansion. The serum from one patient with Cushing's disease, in whom no adrenal tumour could be found at operation, showed a positive reaction before operation. Four patients, who had been cholecystectomized, showed a moderate increase in the melanophore hormone content of their serum on the day after the operation. The serum from two cases with myocardial infarction showed the same result on the second day after the onset of the disease.

The hormone was concentrated from the serum in the following way: 10 ml. serum from each patient was treated with trichloroacetic acid, the filtrate precipitated with phosphotungstic acid and the resulting precipitate treated with barium hydrate. Three frogs were injected for each test.

These experiments seem to show that intermedin and an active adrenocorticotropic hormone peptide are closely related or identical. The frog test seems to be a rapid and simple method of testing for adrenocorticotropic hormone. The method is well suited for the demonstration of an increased content of the hormone in serum.

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Effects of Substituents on Ultra-violet Absorption Spectra

Substituents in a conjugated system do not always shift the absorption bands of the system in the one direction. If we consider only the absorption band of lowest frequency, then the most commonly observed effect is a shift to still lower frequencies[1]. However, Plattner and his co-workers[2] found that

alkyl groups sometimes shift the lowest-frequency band of azulene in the opposite direction. Brown and Lahey[3] found a similar alternating effect of alkoxy groups in N-methylacridone. They emphasized that these shifts could be correlated with the π-electron densities of azulene[4] and N-methylacridone[5] in accordance with the following rule: substituents attached to a position of (local) low π-electron density increase the frequency of the first absorption band, while in positions of high π-electron density the frequency is decreased. It is significant that substituents in alternant[6] hydrocarbons, such as naphthalene, do not occasion these alternating effects[1], and it is just for these systems that the molecular orbital approximation indicates a uniform electron density around the ring system[6].

The results of Miller, Knight and Roe[7] for the fluoroquinolines show a similar correlation with the π-electron densities of quinoline[8], and the hypsochromic shifts discussed by Pianka, Barany and Smith[9] may be interpreted similarly. The alkyl groups in phenyl methyl ketazine and in the methylthiacarbocyanine are attached to carbon atoms of low π-electron density in the parent conjugated systems (benzylideneazine and the unsubstituted cyanine), as may be deduced from the molecular orbital law of alternating polarity[10], and so the resulting hypsochromic shifts fit in with the above generalization. In the case of acetaldehyde 2 : 4-dinitrophenylhydrazone, also discussed by these authors, the methyl group is attached to a position the electron density of which is subject to the opposing tendencies of the nitro groups and the hydrazine nitrogens, and so cannot be judged without explicit calculation; but it is possible that the bathochromic shift occasioned by this methyl substituent also fits into the above generalization. Recent work on carboxy-azulenes[11] shows that the carboxyl group produces shifts in the opposite directions to the preceding three substituents (alkyl, alkoxy, fluoro). It is perhaps significant that the former group is *m*-directing, the latter three *o*,*p*-directing, in electrophilic substitution reactions in benzene. Pianka, Barany and Smith also noticed a correlation of the effect of alkyl groups on dinitrophenylhydrazone spectra with their (chemical) effect upon the hydrolysis of benzhydryl chloride.

On the theoretical side Pullman, Mayot and Berthier[12] have shown that the energy-levels of the various methylazulenes, calculated by the simple molecular orbital approximation, predict frequency changes of the longest wave-length band in both directions relative to azulene itself, but they did not establish any direct theoretical relationship between the sign of the frequency change, the nature of the substituent, and the π-electron density, or other characteristic alternating property of the azulene system. Dewar[13], also on the basis of simple molecular orbital calculations, has shown that for basic dyes an alternating effect of substituents is to be anticipated, and may be correlated approximately with their chemical directive influences. However, his results are not applicable to azulene and similar systems. More recently, Coulson[14] has investigated the effects of substituents on the azulene spectrum and has shown that the complementary shifts occasioned by carboxy and alkyl groups are to be anticipated by the theory.

Alternating shifts are, of course, by no means universal in compounds having fluctuating π-electron densities; for example, the methyloxacarbocyanine corresponding to the methylthiacarbocyanine mentioned above does not show a hypsochromic shift[9], and halogen-substituted pyridines[9,15] exhibit only bathochromic shifts relative to pyridine. But at least it is clear, on both experimental and theoretical grounds, that substituents may produce hypsochromic shifts more frequently than is commonly supposed.

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[1] Jones, R. N., *J. Amer. Chem. Soc.*, **67**, 2127 (1945).
[2] Plattner, Pl. A., *Helv. Chim. Acta*, **24**, 283*E* (1941). Plattner, Pl. A., and Heilbronner, E., *Helv. Chim. Acta*, **31**, 804 (1948).
[3] Brown, R. D., and Lahey, F. N., *Austral. J. Sci. Res.*, A, **3**, 593 (1950).
[4] Coulson, C. A., and Longuet-Higgins, H. C., *Rev. Sci.*, **85**, 929 (1947). Brown, R. D., *Trans. Farad. Soc.*, **44**, 984 (1948).
[5] Brown, R. D. (unpublished results).
[6] Coulson, C. A., and Rushbrooke, G. S., *Proc. Camb. Phil. Soc.*, **36**, 193 (1940).
[7] Miller, W. K., Knight, S. B., and Roe, A., *J. Amer. Chem. Soc.*, **72** 1629 (1950).
[8] Longuet-Higgins, H. C., and Coulson, C. A., *Trans. Farad. Soc.*, **43**, 87 (1947).
[9] Pianka, M., Barany, H. C., and Smith, C. G., *Nature*, **167**, 440 (1951).
[10] Coulson, C. A., and Longuet-Higgins, H. C., *Proc. Roy. Soc.*, A, **192**, 16 (1947).
[11] Plattner, Pl. A., *et al.*, *Helv. Chim. Acta*, **34**, 971 (1951).
[12] Pullman, B., Mayot, M., and Berthier, G., *J. Chem. Phys.*, **18**, 257 (1950).
[13] Dewar, M. J. S., *J. Chem. Soc.*, 2329 (1950).
[14] Coulson, C. A. (unpublished results).
[15] Spiers and Wibaut, *Rec. trav. chim.*, **56**, 573 (1937).

Breakdown of the Lambert–Beer Law

At various times doubts have been cast upon the validity of the Lambert–Beer law; particularly as applied to suspensions of powders in a dispersing fluid.

For this case the law may be written:

$$\log_{10} I_0/I_1 = C.l. \sum_{0}^{d_{max.}} K_x.n.d_x^2,$$

where C is the concentration of the powder in gm./cm.^{3}, l the length of the light-path through the suspension, K_x a factor depending upon the particle size and shape, n the number of particles of size d_x per gram of powder, d_x a characteristic dimension of the particle, and I_0 and I_1 the intensities of the incident and emergent light-beams respectively.

For a definite apparatus of known size, the dimension l is fixed, and for a given powder the term $\sum_{0}^{d_{max.}} K_x.n.d_x^2$ has an assigned unique value, so it follows that the relationship

$$\log_{10} I_0/I_1 \propto C,$$

then holds, provided the Lambert–Beer law is valid.

This relationship has been investigated by use of an apparatus (Fig. 1) consisting of a light-proof box in which is housed a rectangular glass cell, of 5 cm. side, containing the suspension. Across the cell is projected a parallel beam of light, of 0·33 cm. diameter, which afterwards falls upon a photometer consisting of a barrier-layer photo-cell or of a 931*A* electron-multiplier, as is required by the light intensity; the photo-sensitive surface is masked by removable stops of known diameter placed at *B*.

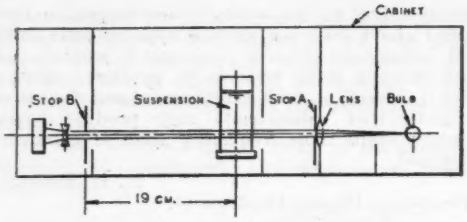

Fig. 1

The experimental results are plotted in Fig. 2, and the other results are given in the accompanying table.

Material	Colour of material	Suspension fluid	Diameter of stop B (cm.)	Solid angle subtended by stop (solid radians)
Silica (test A)	White	Water	0·33	0·00024
,, (test B)	,,	,,	2·20	0·0115
Zircon	,,	,,	0·33	0·00024
Ilmenite	Black	,,	0·33	0·00024

Examination of these results shows that :

(*a*) For silica sand with the small stop (test *A*) there is a barely significant deviation from the Lambert–Beer law for values of I_0/I_1 up to about 1,000, whereas for the same sample but with the large stop in position (test *B*) a significant deviation occurs for values of I_0/I_1 exceeding about 10.

(*b*) With the small stop in position, the white powder (zircon), which has a high reflectivity, shows marked deviations from the Lambert–Beer law for values of I_0/I_1 exceeding about 1,000, although for values up to about that figure the deviation is very small and agrees well with that for silica tested at the same size of stop. For the black powder (ilmenite), however, which has a low reflectivity, no marked deviations occur until values of I_0/I_1 of about 10^6 are reached.

From these results it follows that deviations from the law are minimized under conditions of low reflectivity of the powder, or of reduced probability of the collection by the photo-sensitive surface of light scattered by the particles in the suspension. Conversely, deviation from the law is increased by use of powders of high reflectivity or of a collector which gathers an appreciable quantity of scattered light.

Thus it appears probable that the deviations from the Lambert–Beer law which have been encountered in practice arise from the collection of the light scattered from the particles in the suspension by a photometer which subtends an appreciable solid angle at the middle of the suspension. It also follows from these experiments that, for concentrations used in measurement of powder size (less than about 0·2 gm./litre), no significant deviations occur provided the photosensitive surface subtends, at the middle of the suspension, a solid angle not exceeding about 0·00025 solid radian.

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Sept. 17.

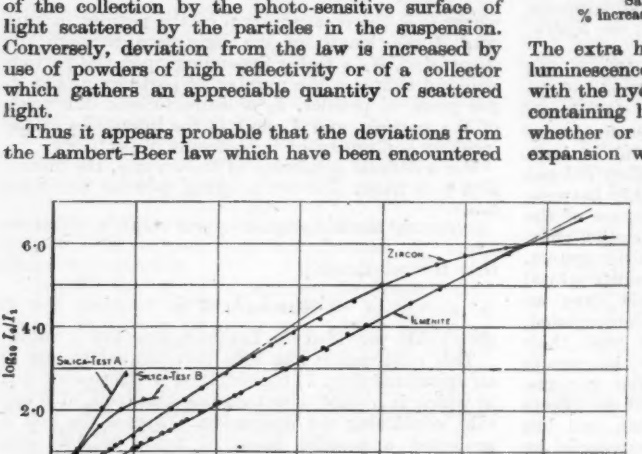

Fig. 2

Role of Hydrogen Atoms in Flames: an Expansion Phenomenon

Recent communications from this laboratory[1,2] have discussed the importance of atomic hydrogen in relation to sodium *D*-line emission from flames containing sodium salts. This note describes further experimental work, on the same subject, in which particular emphasis has been placed on the dimensions of flames.

When flames were contaminated with sodium salts, the visible luminous envelope was greater than with 'clean' gases. This apparent expansion depended on the fuel, the mode of combustion, and the nature of the sodium salt. For example, the following increases in length of the luminous envelopes were measured when sodium chloride was vaporized into diffusion flames which were 3–5 cm. in height before contamination.

Fuel	Hydrogen	Methane	Ethylene	'Calor' gas	Carbon monoxide
% increase in height due to addition of sodium chloride	102	55	25	18	13

Using the hydrogen flame, the following increases were measured with different sodium salts :

Salt	NaCl	NaI	Na_2SO_4
% increase in height	102	112	80

The extra height appeared to be due to additional luminescence due to emission of the *D* lines : thus with the hydrocarbon flames, the tip of the envelope containing luminous carbon was at the same height whether or not the flame was contaminated. The expansion was substantially greater for a reversed flame of air burning in coal gas than for a normal diffusion flame of coal-gas in air, and an even more striking demonstration of what is thought to be the same expansion phenomenon was provided by aerated flames in a Smithell's separator. The accompanying photograph shows the appearance of the separated flames of coal gas contaminated with sodium chloride, the lower cone being increased in height by 500–600 per cent. Even greater expansions were observed with methane, whereas carbon monoxide showed no expansion. There was a much stronger *D*-line emission from the lower than from the upper cone of the flames. Additions of small amounts of hydrogen to the inter-conal

(a) Height of cone without addition of sodium chloride; (b) 'expanded' flame containing sodium chloride

gases materially increased the emission in the upper cone, but corresponding quantities of carbon monoxide had very little effect.

Any interpretation of the above observations must account for the following important facts: (i) for a given fuel, the expansion increases in the order, normal diffusion < reversed diffusion < separated premixed; (ii) the expansion depends on the fuel and the nature of the sodium salt; (iii) the upper cone of separated flames shows a relatively feeble *D*-line emission.

There is no doubt that, in all three types of flame, sodium is excited in a region which was not emitting visible light in the uncontaminated flames, for the life of the excited atoms is far too short to permit of excitation in the main flame envelope followed by emission of the *D* lines in the outer, originally dark region.

The magnitude of the expansion and its variation with type of fuel favour the view that an appreciable quantity of sodium atoms is also *formed* in the originally dark region. The present observations, together with the mechanism of sodium atom formation adopted in a previous communication[2], suggest that the extent of the expansion would be related to the tendency for free hydrogen atoms to diffuse from the reaction zone into the dark region surrounding the flames. The expansion would then depend mainly on the number of hydrogen atoms diffusing out and on the rate at which they are removed by chemical reaction. Of the fuels used, the hydrogen diffusion flame would be expected to show the greatest expansion, because of the high concentration of hydrogen atoms in its reaction zone and the absence of very large molecules (*M*) (such as carbon dioxide) which can effect the reaction $H + H + M \rightarrow H_2 + M$.

The order of the expansion for a given fuel can be predicted as: separated premixed > reversed diffusion > normal diffusion, for several reasons. First, the premixed flame is the hottest of the three, so that the concentration of hydrogen atoms is largest. Second, the original flame envelopes in both the separated premixed and reversed diffusion flames are surrounded by an oxygen-free atmosphere; and this favours a long life for hydrogen atoms outside the original flame envelope.

The expansion would be expected to vary with the nature of the sodium salt because of the variable tendency for the reaction[3] $NaX + H \rightarrow Na + HX$ to occur in the originally dark region outside the flame. The weak sodium *D*-line emission in the upper cone of the separated flame is probably due to the low concentration of hydrogen atoms in the presence of the combustion products from the lower cone[2].

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[1] Arthur, J. R., *Nature*, **165**, 557 (1950).
[2] Arthur, J. R., Bangham, D. H., Baulk, R. H., and Whittingham, G., *Nature*, **166**, 358 (1950).

Addition Compounds of Silicon Tetrachloride

Silicon tetrachloride forms 1 : 4, 1 : 2 and 1 : 1 addition compounds with amines. Only one monoaminate has been identified (silicon tetrachloride : dimethylaniline); but the tetraminates and the diaminates are general occurrences when amines (butylamine, diethylamine, triethylamine, tributylamine, piperidine, pyridine, dimethylaniline, aniline) are mixed with silicon tetrachloride. The addition compounds appear immediately as fine-grained insoluble precipitates; when dried, they are powders. They can be prepared independently of one another by controlling the concentrations of the reactants. The white tetraminates are chemically less reactive and thermally more stable than the coloured diaminates. The tetraminates begin to decompose at temperatures above and below 100° C. A complete report is being published in the *Canadian Journal of Chemistry*.

Organic molecules containing oxygen are also added to silicon tetrachloride; but the compounds formed are physically rather different from the aminates. When silicon tetrachloride is mixed with alcohols, ketones, acids or esters, at low temperatures, yellow solutions develop. On warming to room temperature the yellow solutions remain unchanged if the silicon tetrachloride is in excess, unless the solutions contain alcohol, and then a disruptive chemical reaction occurs. If the organic component is in excess (that is, about 80 per cent by volume), the yellow solution changes colour at room temperature, and, at the same time, solidifies, transforming into a homogeneous, transparent, brittle, non-fuming solid, with no evidence of chemical reaction other than addition. Often the solids slowly shrink, exuding liquid. The time required for these changes, and the hardness of the 'jell' that finally forms, vary with the concentration and with the chemical identity of the organic component. The comparatively hard alcohol 'jells' (methyl, *n*-propyl, *n*-amyl and benzyl alcohols), and the softer acid and ester 'jells' (butyric and heptanoic acids, ethyl acetate and amyl acetate) remain colourless and transparent. The hard, red, aldehyde (butyraldehyde, heptaldehyde) and ketone (acetone, *cyclo*pentanone, mesityl oxide) 'jells' ultimately turn black. In contrast, the ether solutions (butyl ether, anisole, phenyl ether) of silicon tetrachloride remain liquid. The colour of the silicon tetrachloride – butyl ether solutions, as measured with a spectrophotometer, is most intense at a mole ratio of 2 : 1. These observations cover a period of three months.

The ease and prolificacy with which silicon tetrachloride forms addition compounds with donor groups raises the question of what vacant and available orbitals will be assigned to the silicon tetrachloride

molecule. If these orbitals are to be related to the silicon atom itself, it may be necessary to assume that the unoccupied silicon 4*s*, 3*d*, 4*p* atomic orbitals are the electron acceptors, becoming stronger, in this sense, because of the electronegativity of the chlorine atoms.

The physical state of the addition compounds—whether they are insoluble powders, solutions, or homogeneous 'jells'—is apparently to be related to the electron donor, rather than to the silicon tetrachloride. The amines, able to make only one co-ordinate bond, are added to silicon tetrachloride to form definite compounds that could reasonably be distinct molecular species. On the other hand, the possibility that both donor and acceptor groups may become co-ordinately polyvalent can rationalize an extended three-dimensional structure in the addition compounds of silicon tetrachloride and organic molecules containing oxygen.

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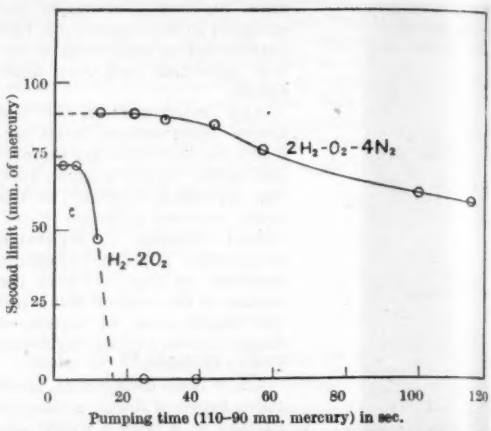
Nova Scotia. Sept. 17.

Second Limit of Hydrogen–Oxygen Mixtures by the Withdrawal Method

During the course of preparations for the study of the inhibiting action of hydrocarbons on the second limit of hydrogen–oxygen mixtures, an unexpected influence of rate of evacuation has been found when using the withdrawal method in clean 'Pyrex' vessels. This effect is particularly marked at higher oxygen concentrations, and with a pre-mixed H_2–$2O_2$ mixture, no explosion occurs if the evacuation-rate is reduced below a critical value of the order of 1 mm./sec. The same critical influence is observed if the oxygen concentration is reduced by replacement with nitrogen, though here the pumping speed required is lower, and the second limit is reduced rather than entirely eliminated. Typical results are shown in the accompanying graph. The evacuation-rate was controlled by interchangeable capillaries, and the abscissa represents the time for the capillary to reduce the pressure from 110 mm. to 90 mm. mercury, this forming a convenient method of characterizing the capillary. Similar results are obtained in various-diameter clean 'Pyrex' vessels (13–40 mm.) and between 460° and 500° C., but the effect is completely absent in vessels coated with potassium chloride. It is hoped to publish a full account of the results later.

The only conceivable reaction products capable of preventing explosion are water, the inhibiting effect of which is well known, and the HO_2 radical, which might produce inhibition by self-termination reactions such as: $HO_2 + OH = H_2O + O_2$. Recent work[1], however, suggests that HO_2 is more likely to give quadratic branching than self-termination.

The production of water during the slow evacuation cannot easily be demonstrated by pressure changes, as these would be indistinguishable from those due to the evacuation. Nor, owing to the ease of absorption of water vapour, can its formation be shown with certainty by gas analysis. If, however, the explosion boundary is approached by raising the temperature, the only change of pressure observable prior to explosion should be a rise due to the thermal expansion of the gas; any decrease can thus be attributed to water formation (which occurs only close to or on the boundary; the reaction-rate well above the boundary is negligible under these conditions).



Effect of evacuation-rate on second limit of hydrogen – oxygen mixtures. Clean 'Pyrex' vessel, 23 mm. diameter, at 500° C.

A mixture of $2H_2$–O_2–$4N_2$ at a pressure of 83·5 mm. and at 483° C. was heated at a rate of about 2–3° C./min. in a clean 35-mm. diameter 'Pyrex' vessel. This mixture should have exploded at about 492° C.; but no explosion occurred even up to 510° C. During the temperature rise from 483° to 491° C., the pressure gradually rose as a consequence of the thermal expansion; but above the latter temperature, the pressure first reached a steady value, and then fell slightly. Comparison of the calculated and actual pressures at the highest temperature indicates the formation of 4·6 mm. pressure of water vapour. Further confirmation comes from the fact that when the mixture at the highest temperature was rapidly evacuated, explosion occurred at 77 mm. pressure instead of 116 mm. This reduction, from the known inhibiting effect of water, corresponds to the presence of about 4·2 mm. pressure of water, in good agreement with the above value.

Two possible mechanisms may be suggested to account for the inhibition. The first explanation assumes that the net branching factor φ becomes initially positive as the explosion boundary is crossed, but that, owing to the slow rate at which φ rises above zero with slow evacuation-rate, the inhibiting effect of the water produced is able to reduce φ to zero before explosion can develop. This possibility, which is to be expected on general grounds, can be demonstrated mathematically for simplified cases.

The second explanation arises if the possibility of quadratic branching in clean 'Pyrex' vessels is considered, as a result of the reaction: $H + HO_2 = 2OH$, suggested by Egerton and Warren[1]. The differential equation for hydrogen atom concentration then takes the form:

$$dn/dt = n_0 - gn + \delta n^2,$$

and the transition from stationary to explosion conditions occurs when $4n_0\delta = g^2$. The stationary hydrogen atom concentration at the boundary is obtained by writing $d/dt(dn/dt) = 0$, giving $n = g/2\delta$. If the explosion boundary is crossed slowly, as when using a slow capillary, the rate of water formation resulting from this stationary concentration of hydrogen atoms may be sufficient to inhibit the explosion.

The fact that the pumping speed effect is not obtained in vessels coated with potassium chloride,

where this quadratic branching becomes unimportant, suggests that the latter explanation is correct. A 'self-inhibiting' mechanism of the first type may perhaps account for the inhibiting action of methane, which has been described elsewhere[2].

R. R. Baldwin
R. M. Precious

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Hull. Sept. 13.

[1] Egerton, A., and Warren, D. R., *Proc. Roy. Soc.*, A, **204**, 465 (1951).
[2] Baldwin, R. R., Corney, N. S., and Precious, R. M., *Nature* [**169**, 201 (1952)].

Effects of Alkyl Groups in Electrophilic Additions and Substitutions

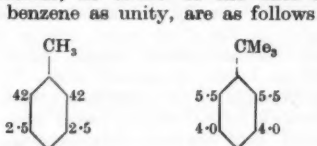
Kharasch has shown that the addition of hydrogen iodide, and, homolytic processes being suppressed, of other hydrogen halides to propylene and other monoalkylethylenes, involves a practically exclusive terminal uptake of the hydrogen atom[1]. Holleman showed that the nitration of toluene involves a 96–97 per cent *ortho-para*-orientation[2]. It has been found quite generally that alkyl-oriented additions and substitutions are accompanied by large increases of reaction-rate[3], for example, by a factor of 24·5 for the nitration of toluene as compared with that of benzene. It is a question for discussion whether these strong kinetic effects of alkyl groups are to be credited mainly to hyperconjugation between CH-bonds and the olefinic or aromatic π-system, or to the inductive effect of alkyl groups arising in these cases from an electrical dissymmetry in a σ-CC-bond formed by differently hybridized carbon-atomic orbitals[4]. Evidence on this matter can be obtained by rate-comparisons between the relevant reactions of methyl- and *tert.*-butyl-substituted ethylenes and benzenes. Of these substituents only methyl can provide CH-hyperconjugation. Both groups should have similar positive inductive effects, that of the *tert.*-butyl group being the greater.

Propylene and *tert.*-butylethylene have been compared with respect to rate of addition of hydrogen iodide. The relative rates, determined by the competition method, in solvent methylene chloride at − 80° were 1·00 : 0·88. The circumstance that the rates are so nearly the same, while a weak steric effect might be held responsible for the direction of the difference, shows that hyperconjugation is not an outstanding cause of the strong kinetic effects of alkyl groups in general, and that therefore these effects must be credited largely to the σ-bond dissymmetry which we classify with the inductive effect. Incidentally, the product from *tert.*-butylethylene contained, besides 50 per cent of $Me_2C.CHI.CH_3$, 50 per cent of Wagner-rearranged $Me_3CI.CHMe_2$. This result is not the first indication of its kind that such additions occur in steps by way of a carbonium ion[5].

Analogous results have been obtained for the nitration of toluene and *tert.*-butylbenzene. In 90 per cent aqueous acetic acid at 45°, the proportions of the products, determined by infra-red analysis, were as follows :

	Ortho-	*Meta-*	*Para-*
Toluene	56·5	3·5	40·0
tert.-Butylbenzene	12·0	8·5	79·5

One sees that the ratios *m*-/*p*- are roughly the same, and that the large differences are in the ratios *o*-/*m*- and *o*-/*p*-. This indicates that the distinction is especially associated with the *o*-position; and the simplest interpretation is that, while the polar effects of the substituents are not very different, the larger group exerts a selective steric repression of *o*-substitution, as LeFèvre[6] has always maintained*. This interpretation is confirmed by comparison of rates. The kinetically determined ratio of the first-order nitronium-ion rates in 90 per cent aqueous acetic acid at 45°, nitrous-free nitric acid being in constant excess, is Me : Bu^t = 1·00 : 0·64. From the figures given, it can be computed that the rates of attack on the individual nuclear positions of toluene and *tert.*-butylbenzene, in terms of the rate for one position in benzene as unity, are as follows :



As before, the conclusion is that the most important polar effect of alkyl groups in these electrophilic reactions in an attached π-electron system is their inductive effect, the expected greater importance of which in the *tert.*-butyl group than in the methyl group accords with relations shown by the *m*- and *p*-rates, which alone are free from the disturbance of steric retardation.

We wish to thank Prof. C. K. Ingold for his interest and help in these investigations.

* *Added in proof :* In a paper which appeared after this communication was submitted for publication, K. L. Nelson and H. C. Brown (*J. Amer. Chem. Soc.*, 73, 5605; 1951) have reached a similar conclusion on the basis of their estimates (employing fractional distillation techniques) of the isomeric ratios for the nitration of *tert.*-butylbenzene with HNO_3—H_2SO_4, as compared with the known ratios for toluene under similar conditions.

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Marion G. Peeling

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Oct. 31.

[1] Kharasch, M. S., *et al.*, *J. Amer. Chem. Soc.*, 55, 2531 (1933), *et seq.*
[2] Holleman, A. F., Vermeulen, J., and de Mooy, W. J., *Rec. trav. chim.*, **33**, 1 (1914).
[3] Ingold, C. K., Lapworth, A., Rothstein, E., and Ward, D., *J. Chem. Soc.*, 1959 (1931). Ingold, C. K., and Ingold, E. H., *ibid.*, 2354 (1931). Robertson, P. W., *et al.*, *ibid.*, 1509 (1939), *et seq.*
[4] Walsh, A. D., *Disc. Farad. Soc.*, **2**, 18 (1947).
[5] Whitmore, F. C., and Johnston, F., *J. Amer. Chem. Soc.*, 55, 5020 (1933). Ecke, G. G., Cook, N. C., and Whitmore, F. C., *ibid.*, 72, 1511 (1950).
[6] LeFèvre, R. J. W., *J. Chem. Soc.*, 980 (1933), *et seq.*

Hypotheses relating to the Brain–Mind Problem

May I be permitted, at this late date, to comment on Prof. J. C. Eccles's "Hypotheses relating to the Brain–Mind Problem" (*Nature*, July 14, 1951, p. 53), which had previously escaped my notice.

As one of four "subsidiary hypotheses" he proposes : "Only when there is a high level of activity in the cortex (as revealed by the electroencephalogram) is liaison with mind possible. Unconsciousness supervenes instantly the activity is lowered (as, for example, in anoxia, anæsthesia, concussion, sleep)". This would be well enough as a hypothesis if it were not for the phrase "as revealed by the electroencephalogram", which implies that a high level of

electroencephalographic activity is lowered as unconsciousness replaces full awareness.

The observed variables in the electroencephalogram are amplitude, frequency and pattern, both spatial and temporal. A high level of activity can scarcely refer to the last, and must be concerned with frequency or amplitude, probably the latter. While it is true that in all the four listed states of unconsciousness there is a general tendency toward lowering of frequency, in the lighter stages of anæsthesia (particularly after barbiturates) and of sleep, there is usually an initial rise in frequency. Amplitude, on the other hand, except in the most profound unconsciousness when 'mind' has long since left its home, commonly rises.

As an example of the mistaken premise on which Prof. Eccles's hypothesis is based one might take the case of 'flat' electroencephalograms. These are unusual, but not rare, in normal fully conscious adults; no activity can be recognized with an amplitude of more than a few microvolts. If the possessor of such an electroencephalogram goes to sleep, it is likely that quite a pronounced rise in amplitude of both alpha rhythm and 12–14 c./s. sleep spindles will occur, followed by slow irregular waves with an amplitude of 50–100 μV.; at no time will there be any lowering of activity until the subject is once again fully awake.

It is a pity that Prof. Eccles's attractive proposition should contain such a statement as "an explanation is provided for the invariably observed failure of mind–brain liaison when the electroencephalogram reveals depressed cortical activity".

Nothing in the chapters of mine to which he refers in support of the hypothesis set out above seems to me to bear the interpretation put upon it, and I can only regret any ambiguity of expression which allowed such a conclusion.

W. A. Cobb

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I regret that Dr. W. A. Cobb takes exception to my quotation of his article in "Electroencephalography"[1] in support of my statement that the unconsciousness of concussion is associated with a depressed activity of the cerebral cortex as revealed by the electroencephalogram (E.E.G.). The misunderstanding apparently has arisen because Dr. Cobb is considering merely the wave form of the electroencephalogram and I was specifically referring to the "activity in the [cerebral] cortex as revealed by the electroencephalogram". I must confess that electrophysiologists must accept responsibility for such misunderstanding, because we have given the electroencephalographers very little help in the interpretation of their electroencephalogram records, and they perforce have invented a descriptive nomenclature and empirically related the different types of wave forms to various cerebral disorders. In this context reference may be made to my review on the "Interpretation of Evoked Potentials in the Cerebral Cortex"[1]. An attempt is there made to show how these potentials may be explained by the known electrical responses of nerve cells. The relevant point for the present discussion is that the electroencephalographers assess activity by simple reference to the electrical wave forms they record, whereas my phrase "activity in the [cerebral] cortex" refers to an assessment of the level of active neuronal responses in the cortex. Admittedly there is much uncertainty in such assessment, but there is good evidence that intense patterned neuronal activity would give a very small and rapid electrical wave-form, whereas large slow potential waves indicate a low level of activity which would be largely attributable to synaptic potentials that are generated in cortical neurones by afferent discharges to the cerebral cortex. A further point is that recording from the scalp, as is usual in clinical electroencephalography, is so inefficient that the small rapid electrical activity is likely to be lost in the general noise background, as presumably occurs in the so-called 'flat' electroencephalogram on which Dr. Cobb bases so much of his argument.

An electrophysiologist would place much more weight on records directly from the cerebral cortex. My reference to Dr. Cobb's article in "Electroencephalography" referred to his account of concussion, in which he referred specifically to the work of Williams and Denny Brown on concussion in animals. Complete silence of the electroencephalogram was observed, and is a highly significant observation because it was directly and immediately recorded from the exposed cerebral cortex. The reported recordings in cases of human concussion were always made much later (usually many hours) after the concussion, but they too gave a general indication of lowered neuronal activity. On carefully re-reading Dr. Cobb's article, I can only say that to me it bears precisely the interpretation that I originally placed upon it in my article.

J. C. Eccles

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Oxford.

[1] *E.E.G. Clin. Neurophys.*, **3**, 449 (1951).

Chairs of Chemistry in Great Britain

In *Nature* of January 26, Prof. Alex. Findlay rightly challenges the claim that the regius chair of chemistry in the University of Glasgow founded in 1818 was the first chair of chemistry in Britain. Had he confined himself to Scottish chairs, his plea for the recognition of the Aberdeen chair founded in 1793 would have been valid, but surely he goes too far in claiming the latter as the first in Great Britain. At least one chair—that which, under the revised title of organic chemistry, I have had the honour of occupying since 1944—antedates the Aberdeen foundation by close on a century. According to the University Ordinances, the chair of chemistry in the University of Cambridge was created (albeit with no stipend) in 1702, its first occupant being John Francis Vigani, who had been settled in Cambridge for some years before that time as a private tutor in chemistry. Vigani's successors in office (with dates of their election) were: J. Waller (1713); J. Micklebourgh (1718); J. Hadley (1756); R. Watson (1764); I. Pennington (1773); W. Farish (1794); S. Tennant (1813); J. Cumming (1815); G. D. Liveing (1861); W. J. Pope (1908). An account of the history of the chair and of the University Chemical Laboratory was published in 1928 by Dr. F. G. Mann (*Chem. and Indust.*, **6**, 690 (1928).

A. R. Todd

University Chemical Laboratory,
Cambridge.
Jan. 28.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 18

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Council Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. R. S. Silver: "The Methodology of Applied Science".

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. A. J. P. Oort: "The Specialization and Differentiation of Pathogenic Organisms in relation to Plant Breeding".* (Further Lecture on February 19.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Prof. Niels Bjerrum: "The Structure and Properties of Ice" (Jubilee Memorial Lecture).

SOUTH-EAST LONDON TECHNICAL COLLEGE (at Lewisham Way, Lewisham, London, S.E.4), at 7 p.m.—Mr. P. Grodzinski: "The Technology of the Machining of Diamond".

TEXTILE INSTITUTE, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—"New Fibres".

Tuesday, February 19

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Miss Cecily de Monchaux: "Experimental Studies of Group Behaviour".*

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. F. C. Lant and Dr. J. C. Weston: "An Investigation of Whole-House Heating".*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. M. Thoday: "The Mechanism of Radiation-Induced Chromosome Mutation".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. A. Summerlin: "The Automatic Compensation of Zero-Drift Errors in Direct-Coupled Feedback Systems"; Mr. K. Kandiah and Mr. D. E. Brown: "High-Gain D.C. Amplifiers"; Mr. S. W. Noble and Mr. P. J. Baxandall: "Design of a Practical D.C. Amplifier based on the Second-Harmonic Type of Magnetic Modulator".

INSTITUTION OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. J. B. Matthews: "Developments in Laboratory Methods and Technique".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Electrographic Analysis".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. K. G. Wilkinson: "Recent Development in Glider Design".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at the St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. R. A. Peel: "Turkey Red Dyeing in Scotland—its Heyday and Decline".

WOMEN'S ENGINEERING SOCIETY, LONDON BRANCH (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—"The Women's Engineering Society" (Miss A. S. Lockhart: "The Early Days—an Historical Review"; Miss D. Pile: "The Society—Post-War and Onwards").*

Wednesday, February 20

ROYAL METEOROLOGICAL SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Discussion on "Meteorology and the Operation of Jet Aircraft" (to be opened by Air Commodore G. Silyn Roberts, Capt. A. M. A. Majendie, Group Capt. C. G. Lott, Mr. G. J. W. Oddie and Mr. C. S. Durst).*

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir William Ogg: "Modern Developments in Soil Science" (Fernhurst Lecture).

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Dr. J. H. Schulman: "The Physics and Chemistry of Molecular Interactions at Interfaces, with special reference to Haemolysis, Lipoprotein Associations, Fat Emulsion Systems and the Possible Mode of Action of some Biologically Active Molecules".* (Further Lecture on February 21.)

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. P. L. Stride: "Search Radar for Aircraft".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Crowther: "Extrusion".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. R. L. Kenyon: "The Organization of the Chemical Profession in the U.S.A.".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Physics Lecture Theatre, College of Technology, Manchester), at 7 p.m.—Mr. S. R. Wilkins: "Development in Multi-Range Electronic Measuring Instruments".

INSTITUTION OF ENGINEERING INSPECTION, NORTH-WESTERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 7.30 p.m.—Mr. J. F. Hinsley: "The Non-destructive Testing of Materials".

Thursday, February 21

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "Excitation and Inhibition" (to be opened by Dr. J. C. Eccles, F.R.S.).

BIOMETRIC SOCIETY, BRITISH REGION (at the Wellcome Research Institute, 183 Euston Road, London, N.W.1), at 2.15 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. A. L. Lehninger (Chicago): "Mitochondria and Biological Oxidations and Phosphorylations".* (Further Lectures on February 28, March 6 and 13.)

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. S. M. Manton, F.R.S.: "Developments and Science in the Soviet Union".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Interference and Diffraction as General Wave Properties". (Further Lectures on February 28, March 6 and 13.)

UNIVERSITY OF LONDON (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. S. Thorarinsson: "The Physical and Historical Geography of Iceland".* (Further Lecture on February 26.)

UNIVERSITY OF LONDON (in the Department of Education, King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. W. R. Niblett: "Education and Individuality".*

PRESENTATION OF TECHNICAL INFORMATION DISCUSSION GROUP (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6 p.m.—Mr. B. C. Brookes: "The Teaching of P.T.I.".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. T. Reichstein (Basle): "The Chemistry of the Cardiac Glycosides" (Centenary Lecture).

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. A. T. Green: "Recent Trends in Refractories Research".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. P. A. Buxton, F.R.S.: Symposium on "Insecticides".

Friday, February 22

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 4 p.m.—Discussion on "'Knock' in Petrol Engines".

ROYAL ASTRONOMICAL SOCIETY (joint meeting with the GEOLOGICAL SOCIETY, at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Interpretation of Gravity Surveys" (Speakers: Dr. G. M. Lees, F.R.S., Mr. B. C. Browne, Mr. P. Evans, and Mr. N. L. Falcon).

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Mr. R. B. Braithwaite: "A Defence of Teleological Ethics".*

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. D. H. Everett: "There and Back Again—Some Aspects of Hysteresis" (Bedson Club Lecture). (All Fellows are invited.)

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the AUTOMOBILE DIVISION and [the INTERNAL COMBUSTION ENGINE GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. D. Davis: "Factors governing Anti-knock Requirements of Automobile Engines"; Mr. D. Downs and Mr. R. W. Wheeler: "Recent Developments in 'Knock' Research"; Mr. M. J. Eatwell and Mr. J. G. Withers: "The Significance of Octane Numbers in relation to Road Performance".

MANCHESTER STATISTICAL SOCIETY, STATISTICAL METHODS STUDY GROUP (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Mr. K. Dearnaley: "Development of the Rayon and Synthetic Fibre Industry".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. E. C. B. Corlett: "Aluminium Alloys as Shipbuilding Materials".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. A. J. Axford: "The Chemistry of Radiographic Film Processing".*

WOLVERHAMPTON SOCIETY OF APPLIED SCIENCE (joint meeting with the BIRMINGHAM AND MIDLANDS SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Technical College, Wolverhampton), at 6.30 p.m.—Dr. S. W. Challinor: "Cider-Making".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Scientific Papers. (Meeting postponed from February 15.)

Saturday, February 23

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (at Bedford College, Regent's Park, London, N.W.1), at 2 p.m.—Symposium on "The Fundamentals of Social Psychology". (All members of the Society are invited.)

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the University, Reading), at 2.30 p.m.—Symposium on "The Metabolism of Calcium and Phosphorus".

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. N. Gavron: "The Role of Patents in Industrial Research and Development, with particular reference to the Chemical Industry".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. H. J. Fleure, F.R.S.: "The People of Britain".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade A) FOR MATHEMATICS AND MECHANICS, Preston Technical Institute, Brighton—The Education Officer, 54 Old Steine, Brighton (February 23).

ASSISTANT (Grade A) IN THE DEPARTMENT OF MECHANICAL ENGINEERING, and an ASSISTANT (Grade B) IN THE DEPARTMENT OF SCIENCE AND RELATED MATHEMATICS—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (February 23).

ASSISTANT MASTER (with an honours or special degree in chemistry, or a good general degree with chemistry as one of the subjects) to teach CHEMISTRY throughout the Secondary Technical School for Boys—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (February 23).

HEAD (Grade II) OF THE CHEMISTRY AND METALLURGY DEPARTMENT, Swansea Technical College—The Director of Education, Education Department, The Guildhall, Swansea (February 23).

SENIOR LECTURER (with high honours degree in chemistry and special knowledge of organic chemistry; experience in teaching advanced classes is essential)—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (February 23).

BIOCHEMIST (part-time, medical qualification not essential) to undertake research and laboratory investigation in connexion with urological disease—The Secretary, St. Paul's Hospital, Institute of Urology, Endell Street, London, W.C.2 (February 25).

SUPERINTENDING SCIENTISTS (3) in the Research and Development Branch of the Department of Supply, Melbourne: (1) under a Controller to be responsible for the co-ordination of the programme of the Long Range Weapons Project and for ensuring that all provisions are made to facilitate its execution, (2) under a Controller to be responsible for the preparation of programmes of proposed scientific projects and their technical assessment, for the direction of field studies in connexion with defence problems, etc., (3) under a Controller to be responsible for the co-ordination and control of the research and development associated with detailed elements of major scientific projects—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (February 25).

TECHNICAL ASSISTANT (with a Science or Engineering degree, or equivalent, and at least two years experience with a patent agent) to the Patents Officer at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/428 (February 28).

GRADUATES IN ELECTRICAL ENGINEERING (with good industrial experience) to teach Machinery and Transformers and Electrotechnology up to Higher National Certificate standard—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19 (February 29).

ASSISTANT PROFESSOR OF MACHINE DESIGN, Indian Institute of Technology, Kharagpur—The High Commission of India, General Department, Aldwych, London, W.C.2, quoting 4/62A (March 1).

ENGINEER (with experience of research work) to take charge of the Engineering Services at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/426 (March 1).

CHAIR OF CIVIL ENGINEERING in the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 3).

I.C.I. (India) RESEARCH FELLOWSHIPS in Physics (including mathematics), Chemistry or Biology (botany and zoology), at any university or institution in India—The Secretary, National Institute of Sciences of India, Mathura Road, New Delhi 1, India (March 3).

SENIOR AND JUNIOR RESEARCH FELLOWSHIPS tenable at any university or institute in India—The Secretary, National Institute of Sciences of India, Mathura Road, New Delhi 1, India (March 3).

DEPUTY CHIEF TECHNICAL ADVISER ON MEAT INSPECTION at the London headquarters of the Ministry of Food—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4123/52 (March 6).

PRINCIPAL RESEARCH OFFICER OR RESEARCH OFFICER (with university degree with honours in science or agricultural science, or equivalent qualifications, with extensive research experience in plant physiology, plant pathology, or plant nutrition) at the Commonwealth Research Station, Merbein, Victoria, to be responsible to the Officer-in-Charge of the Station for the supervision of a research team engaged on plant nutritional and physiological investigation associated with the Murray Irrigation area, and to undertake personal work in this field as part of the Station's programme—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3446 (March 8).

LECTURER IN BACTERIOLOGY (whose principal duty will be the instruction of dental students)—The Secretary, The University, Edinburgh (March 15).

REGISTRAR (university graduate with administrative experience)—The Registrar, University College, Swansea (March 15).

LECTURER (Grade II) IN PHYSICS—The Registrar, The University, Reading (March 17).

ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (March 31).

I.C.I. RESEARCH FELLOWSHIPS in biochemistry, chemistry, engineering, pharmacology, or physics—The Secretary, University Court, The University, Glasgow (March 31).

BERKELEY BYE-FELLOWSHIP for research in medicine, or any branch of natural science excluding medicine—The Registrary, Gonville and Caius College, Cambridge (April 1).

LECTURERS (3) IN THE DEPARTMENT OF ANATOMY, University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 7).

ENGLISH ELECTRIC COMPANY'S BURSARIES IN HYDRO-POWER ENGINEERING—The Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7 (June 1).

AGRICULTURAL CHEMISTS in Nigeria, Kenya and Malaya (duties will include some research together with analytical and advisory work as required; fertilizer trials on food crops will form a large part of the work in Nigeria, in Kenya the post will be specially concerned with pyrethrum, including improvement in methods of analysis and in yield)—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/5.

ANALYST (graduate in chemistry or an associate of the R.I.C.) with experience of analytical work, and a PHYSICIST (graduate) for technological investigations on rubber—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

ASSISTANT (Grade B) IN THE DEPARTMENT OF MATHEMATICS, Bradford Technical College—The Director of Education, Town Hall, Bradford.

ASSISTANT LECTURER (Grade A) IN THE DEPARTMENT OF PHYSICS AND APPLIED PHYSICS, Cardiff College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

COTES RESEARCH FELLOWSHIP in the field of proteolytic enzymes—Dr. E. R. Roberts, Chemistry Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

ENGINEER at a Ministry of Supply Establishment in London, to control a section responsible for the preparation of production and repair programmes for aircraft, aero-engines and associated equipment, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.488/51A.

ENGINEER in the Ministry of Supply at Farnborough, to supervise staff of the Creep Laboratory, and the design, construction and maintenance of its equipment, and the interpretation of the test data obtained—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.39/52A.

ENGINEER by the Ministry of Supply in London (training in heavy automotive engineering and a knowledge of workshop planning and progressing is essential), for the solution of technical problems involved in commencing tank production at a factory in Lancashire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.40/52A.

EXPERIMENTAL OFFICER at the Atomic Energy Research Establishment, Harwell, for technical information work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.11/52A.

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING, Bradford Technical College—The Director of Education, Town Hall, Bradford.

HEAD (Grade III) OF THE DEPARTMENT OF PRODUCTION ENGINEERING, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, Wolverhampton.

LECTURER IN ELECTRICAL ENGINEERING, including A.C. theory—The Principal, Faraday House College, Southampton Row, London, W.C.1.

PHYSICISTS at a Ministry of Supply Research Establishment in Berkshire, for work (of a research and development character) concerned with the use of radioactive materials, radiation measurements, and health physics—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.333/51A.

POSTGRADUATE STUDENTSHIPS in Plant Breeding, Entomology, and Soil Science—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

SCIENCE GRADUATE (experience in bacteriology and serology is essential)—Dr. A. Felix, F.R.S., Central Enteric Laboratory and Bureau, Colindale Avenue, London, N.W.9.

SCIENTIFIC AND ASSISTANT STAFF with qualifications in engineering or physics (including electronics), for work including research in fluid machinery, cavitation, pressure surges, hydraulic models, instrumentation and control mechanisms, etc.—The Director, British Hydromechanics Research Association, Harlow, Essex.

SENIOR EXPERIMENTAL OFFICER (Ref. D.17/52A) for the development of calibration procedure for radio test equipment and preparation of calibration publications; an EXPERIMENTAL OFFICER (Ref. D.18/52A) for the calibration of transfer standards involving output and attenuation measurements; and ASSISTANT EXPERIMENTAL OFFICERS (2, Ref. D.19/52A) for the calibration of transfer standards (*a*) involving frequency and pulse measurements and maintenance of the frequency standard, and (*b*) involving bridge and miscellaneous measurements; at an R.A.F. Signals Experimental Establishment in Bedfordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS in the Royal Naval Scientific Service in the London area and Gloucestershire: (*a*) ELECTRONIC ENGINEERS or PHYSICISTS interested in any of the following modern communication systems—pulse technique, all forms of recording, high-speed data handling, electronic computing and similar techniques, (*b*) MATHEMATICIANS with interests in statistics, probability and automatic computing (S. Os. and S. S. Os. only)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.7/52A.